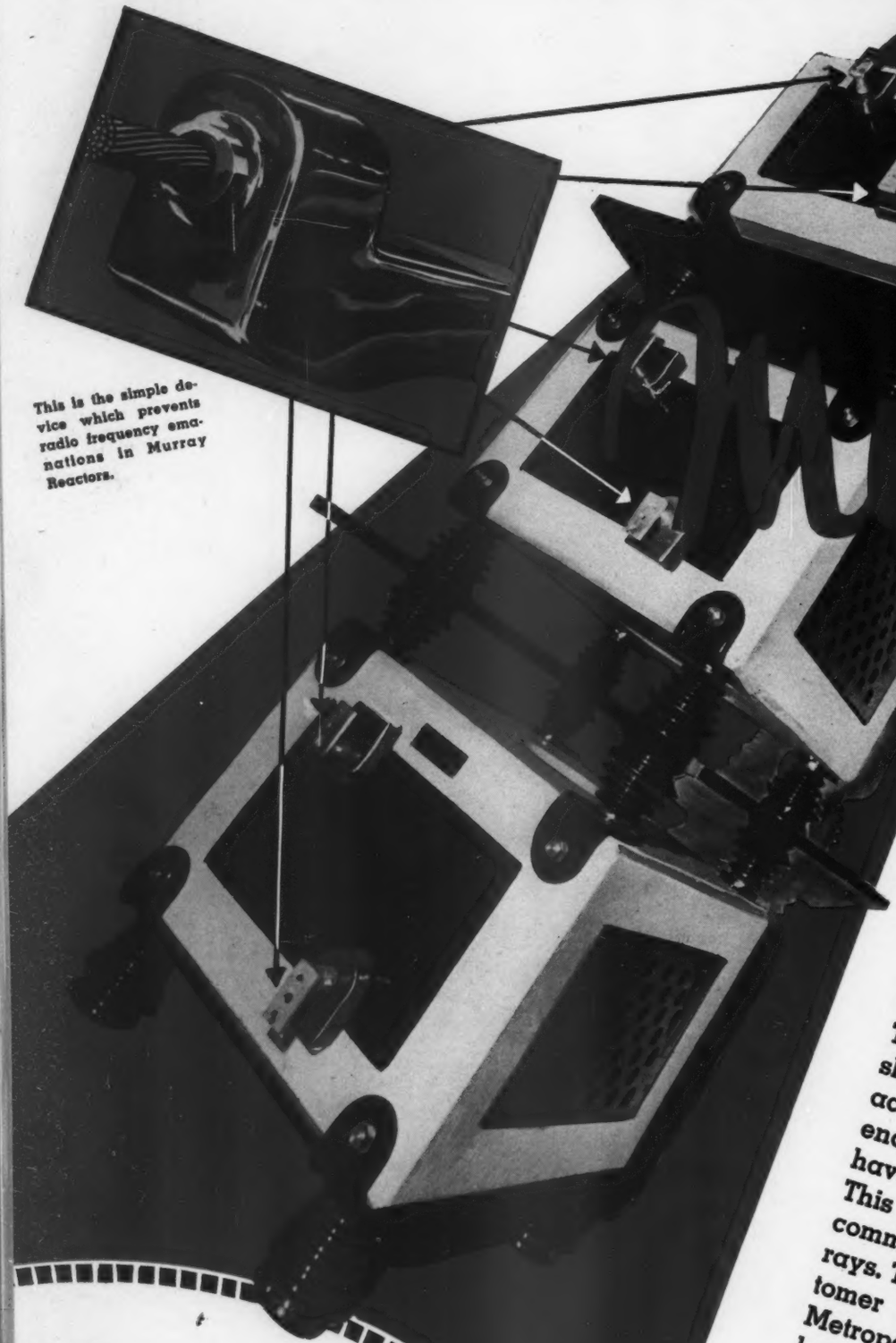
No Radio INTERFERENCE



This is the simple device which prevents radio frequency emanations in Murray Reactors.

Murray CURRENT LIMITING REACTORS

No single annoyance wrecks public good will more than radio interference. Nothing is more exasperating than the "music" of the high frequency emanations of unprotected electrical devices.

The simple, inexpensive device shown above (built into the reactor) PREVENTS radio interference — and only Murray Reactors have this device.

This alone — among many — is a commanding reason for using Murrays. The dividends in increased customer good will are incalculable.

Metropolitan Device Corp., 1250 Atlantic Ave., Brooklyn, New York.

Metropolitan
Device Corp.
Brooklyn, New York

Please send full information on Murray Current Limiting Reactors.

Name_____ Title_____

Company_____

Address_____

Competitive Power

The last three months have provided the utilities with the best kind of ammunition to protect the industrial market against inroads from competitive customer-owned power. When the demand for manufactured products suddenly went into high gear there was no slowing down of production because of a shortage of power. Always there was ample power for all industrial needs.

Had these same industrials been dependent entirely upon their own power plants there would be many that would not have been able to take care of any such rapid increase in business as was experienced since September 1. The actual saving that resulted to them from the flexibility of utility power supply, if it could ever be totaled up, would be found to be several times more than any paper saving that might come from competitive power.

When business is good and manufacturers want additional power in a hurry they automatically turn to the utilities. It is not, then, a case of how much does power cost, but, rather, how soon can it be had. In other words, there is no great competitive problem when the industrial business is good. The real problem comes when manufacturers with business at a low volume begin to look for ways to save money. They then become prospects for purveyors of competitive power equipment. The time, therefore, to prepare for such competition is when business is good and when people can understand and appreciate the advantages as and when they arrive. In other words, it is harder to convince a man about the economy of power flexibility at a time when his power needs are excessively low. The argument makes much more impression on him at the time when he needs power.

Today manufacturers of competitive power equipment are busy in non-competitive markets, largely water and land transportation. As soon as these markets begin to level off the industrial market will once more be attacked and with greater vigor than ever before.

This is a situation which the utilities alone must cope with. It is not like a market development job where the manufacturers of the products can be called upon for co-operation. Nobody is going to help the utilities except themselves. While their business is distinctly local, the aggregate of it is national. Moreover, there are a growing number of national organizations with local branches. Therefore, what happens in Iowa can easily affect a utility in Georgia, or in Texas, or in Massachusetts. The sales arguments in New York do not lose their effectiveness in Wisconsin. In other words, there is no Southern problem, or Pennsylvania problem, or Missouri problem, but there is a national problem.

Since this is the time when industrial customers can best appreciate the value of utility service, this is the time then to start a national co-operative purchased power promotional program. With utility power now in favor by industry, no better time could be found for hammering home the argument.

Fig. 1—City cut-in truck equipped with two wire reels

These reels facilitate the installation of service wires and can be used in either the open or closed position (as shown). They are fastened securely to the truck, but can easily be removed.

Trucks Geared to Specific Utility Duty

Each unit a traveling tool shop, storeroom or powerful mechanical aid — Unnecessary weight and accessories eliminated — Speed, maneuverability, versatility the objectives

G. H. KIEBURTZ, *Supervisor of Transportation, Puget Sound Power & Light Co., Seattle, Wash.*

IN DESIGNING truck bodies for line construction and maintenance we have attempted to provide facilities so that each truck is able to perform a certain class of work within rather broad limits. This seemed necessary in order to avoid using units capable of doing large construction jobs on service work which usually requires light, fast equipment. The result of our experience has been the development of four types of units:

1. City cut-in truck.
2. Suburban cut-in truck.
3. Light line truck.
4. Standard line truck.

The city cut-in truck is a 1½-ton unit with 133-in. wheelbase, designed for service installation and maintenance, and is a light, fast unit, so equipped that it can reach and complete a job in the least possible time (Fig. 1). It is, in effect, a traveling storeroom, having a complete stock of material that might be used during any one-day's work. It is not equipped with a winch or any pole-handling facilities, but has space for five coils of wire in the body of the truck and two coils on reels at the rear, ready for immediate use. Compartments reached from the outside of the truck make tools and material readily accessible and save much time on the job. This truck is designed for a three-man crew, with a folding seat in the rear for an extra man when necessary.

Fig. 2—Suburban cut-in truck, light-weight aluminum derrick

The three-man crew rides in the standard truck cab. The city cut-in truck (see also Fig. 1) has a shorter wheelbase and no winch or derrick. The material and tool compartments are on the right except for the one here shown below the derrick compartment.

The suburban cut-in truck is also for a three- or four-man crew (Fig. 2), but differs from the city cut-in truck in that it is equipped with a winch, power take-off and 18-ft. aluminum derrick for pole-setting work. It is also a 1½-ton truck, but with a 155-in. wheelbase. It has a body similar to the city cut-in, including ventilated rope lockers and tool and material compartments accessible from the outside of the truck. This unit is equipped for hauling a pole trailer and has a hand control valve

in the cab for operating the trailer brakes. A three-gallon insulated water container is standard equipment on this truck. As its name implies, this unit is for use in suburban areas, where the work may range from running a service or setting a service pole to the construction of a rural line extension.

Line Trucks

A 2-ton, 180-in. wheelbase chassis is used for the light line truck and a second cab that will seat four men is incorporated as part of the truck body. This truck is equipped with a winch, power take-off and a 20-ft. tubular steel derrick. In other respects it is similar to the suburban cut-in truck, except that there is more space for tools and material. A five-gallon water container is used in place of the three-gallon one on the suburban cut-in. This truck will accommodate a crew of from five to seven men and is used for general construction and maintenance of distribution lines.

The standard line truck is a 3-ton chassis of 180-in. wheelbase and is equipped the same as the light line truck. It will accommodate a five- to seven-man crew and can handle the heavier construction and maintenance of distribution lines.

In order to provide a device to replace the use of the standard snatch block in certain operations, this company has developed what is called a "Universal tail block" (Fig. 5). This block is mounted on the rear of the truck and allows the line from the truck's winch to operate in a 180 deg. arc either vertically or horizontally. It is particularly advantageous when the truck cannot be pointed directly at the object to which the line is fastened, such as when yarding poles or operating at right angles to the truck when it is standing on a narrow road. The block is universal in that the sheave rotates 360 deg. in a plane at right angles to the line. It has the advantage of a large radius sheave which will not damage the cable when under heavy strain, as when pulling poles or pole butts out of the ground.

We have three types of service units in operation. One of them is the half panel, which is built on a ½-ton pick-up truck (Fig. 6). The pictures show the side compartments and the available loading space in the rear, which will hold an average

Fig. 3—Light line truck

Auxiliary crew compartment easily holds four men. The standard line truck is similar in appearance but on a heavier chassis. An insulated water cask is mounted on the right fender.

Fig. 4—Pole derrick in position on light line truck

Note universal tail sheave at rear.

Fig. 5—Rear view of light line truck

Winch inclosed by removable sheet metal cover. Projection in front of winch cover is for fastening the third leg of pole derrick. Universal tail sheave also mounted.

Fig. 6—Half-panel service truck

Doors open into tool and material compartments from both sides. The horizontal tube just over the fender carries a switch-stick. A similar one on the right is for rubber goods.

Fig. 7—Meter installer's truck—Both sides alike; plenty of meter-carrying space and shelves for small material and tools

size range or refrigerator. The two cylindrical tubes are for a switch stick and rubber goods. These units were developed for the use of the all-around service man, such as would be found in the smaller headquarters, where he might be required to do anything from delivering a range to re-fusing a transformer or running a service.

Another type is the standard service unit, also using a ½-ton pick-up truck. This type is equipped with tool and material compartments on both sides, leaving the entire pick-up box open and available for other use. The extension ladder is mounted on supports at one side of the body in order to provide headroom for any one standing in the truck body. This unit is used for all kinds of service work and it is considered as a general utility service truck.

The third type of service truck (Fig. 7) has so far been confined to meter installation work in Seattle and is equipped for that work alone, although by making some slight changes it could be used in place of the standard service unit. It has similar longitudinal compartments on each side, except that these compartments overhang the pick-up body on the inside, providing a greater depth of box. Individual pockets are provided for fourteen socket type and sixteen bottom connected meters, as well as four combination meters and time switches. On each side between the running board and the meter compartment is a vertical box with shelves for carrying other material, such as screws, tape, fuses, tools, etc. A 4-ft. ladder is carried in the back of the truck. The open, pick-up body can also be used for carrying larger equipment, such as large current and potential transformers, Lewis cabinets, etc.

Fig. 8—Standard pole trailer with stiff-leg and hand-brake—handwinch at rear not visible

Fig. 9—Standard platform or material trailer—as many as three small poles can also be carried

Wire Payout Reels

A wire reel with an expanding hub, used for handling standard coils of wire in connection with the installation of overhead services, is shown in Fig. 1. The wire is drawn directly from the reel with the reel in either the vertical or horizontal position. The principal advantages of this device are:

1. Ease of placing coil on reel.
2. The wire is held tightly, regardless of diameter of coil.
3. Availability of the wire without further handling of the coil after it is placed on the reel.
4. Eliminates kinks and loops in service wires after installation.
5. Reduction in time of installing services.
6. Less waste of wire.

These reels were designed by our engineering department and constructed in our own shop.

As a result of a state law requiring that all vehicles be equipped with cab-controlled brakes, practically our entire fleet of trailers has been re-

[*Continued on page 131*]

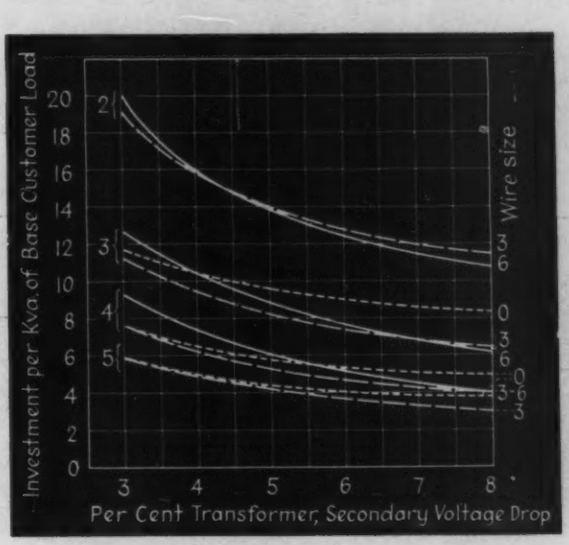
Distribution Planning—V

Transformer-Secondary Design for Service

Principles to apply in economical design of transformer-secondary layout for residential service to provide adequate utilization voltage in consideration of growing loads of cooking, heating and motor-driven appliances

C. E. ARVIDSON, *Commonwealth & Southern Corporation, Jackson, Mich.*

ADEQUATE utilization voltages and economically designed transformer-secondary combinations can be realized by the judicious application of a few general principles which are the result of general economic studies. The design of transformer-secondary combinations depends so much upon the existing facilities and local conditions that it is difficult, if not impossible, to provide definite instructions for the solution of these problems. The purpose of this article is to discuss those general principles which can be used as a guide and which, if followed judiciously, should result in economically designed transformer-secondary combinations which will provide adequate utilization voltages for residential areas.



Comparison of investments for different size conductors on 2400-volt primaries with two-way secondaries

Curves 2—
20 customers per 1,000 ft.
10 per cent ranges,
20 per cent refrigerators

Curves 3
20 customers per 1,000 ft.
40 per cent ranges,
60 per cent refrigerators

Curves 4
40 customers per 1,000 ft.
40 per cent ranges,
60 per cent refrigerators

Curves 5
30 customers per 1,000 ft.
100 per cent ranges,
100 per cent refrigerators

Studies which have been made to determine suitable design voltage limits and an economic apportionment of the design voltage drop indicate that transformer-secondary combinations should be designed for a total transformer and secondary voltage drop of about 6 per cent where primaries are designed for a drop of about 2 per cent between the primary of the first and last transformers. Occasionally on some branches or laterals, where it is impractical to reduce the primary voltage drop to the desired amount, it will be necessary to design the transformer-secondary combinations for less than a 6 per cent drop so that the total primary, transformer and secondary voltage drop does not exceed 8 per cent.

It is not practical or possible to design all transformer-secondary combinations for an exact 6 per cent voltage drop or to redesign a combination when the voltage drop exceeds this amount. It is, therefore, suggested that transformer-secondary combinations be redesigned when the voltage drop for the combination exceeds about 7 per cent or 8 per cent, and that new or redesigned combinations should be designed for a 6 per cent drop or less, depending upon the existing load conditions and present facilities.

Apportionment of Design Voltage

Studies for determining the economic apportionment of the design voltage drop between the transformer and secondary resulted in the general conclusion that an economic apportionment is obtained by loading the transformer to a maximum as limited by its permissible temperature, except when limited by the permissible voltage drop for the transformer-secondary combination. This does not mean that economical transformer-secondary combinations will result only when transformers are loaded to their maximum thermal limit of approximately 150 per cent. Under many conditions, it is possible to have a more economical combination if the transformer is loaded to only about 100 per cent and the remaining permissible drop used in the secondary. It is, therefore, economical and practical to locate the transformer with respect to the existing or new secondary so that the secondary will have a maximum voltage drop in the order of 2 or 3 per cent (not to exceed 3 per cent except in special cases), and to select a transformer which will have a loading of between 90 and 140 per cent of its rating without exceeding the design voltage drop of 6 per cent for the transformer-secondary combination.

It is usually not practical or economical to design transformer-secondary combinations for a definite amount of load growth. This is true because the point at which future loads may be connected to the secondary cannot be predicted. Obviously, a transformer-secondary combination might provide for two or three additional ranges near the

transformer and not be capable of providing adequate service for even one additional range if it were connected to the end of the longest secondary. Experience has shown that transformer-secondary combinations will usually provide for some future load growth if the design principles herein discussed are properly followed. Any additional provisions for load growth will result in additional expenditures which may prove excessive and uneconomical. Where there are two or more possible solutions to a transformer-secondary problem, possibilities for future load growth should receive due consideration in comparing the costs of the different plans, since the increased cost of the plan which provides for future growth will be offset to some extent by the increased revenue and decreased losses resulting from the higher utilization voltages.

Secondary Conductor Sizes

Numerous studies have been made and published relative to the most economical secondary conductor sizes. A review of five of these studies was published in the January, 1937, issue of *Electrical Engineering*. Some of these studies were based upon annual charges including losses, and others were based upon investment costs only. However, all agree that secondary conductor sizes of No. 2, No. 3 or No. 4 are the most economical and practical for new secondary construction. An independent study made by this engineering department substantiates the results mentioned above.

A comparison of investments for No. 6, No. 3 and No. 1/0 secondaries for 2,400-volt primaries is shown in the accompanying illustration. Since the permissible transformer-secondary voltage drop will usually be about 6 per cent it can be seen that No. 6 is the most economical secondary conductor size only in areas of very light load density, and No. 1/0 conductor is not economical for any of the load densities considered. Similar curves for 4,160-, 4,800- and 7,200-volt primaries show the same general relationship. The following conclusions regarding secondary conductors apply to the design of residential distribution secondaries:

1. Use No. 3 conductor for all new secondary construction except in very lightly loaded areas having little possibility of future load growth and in very heavily loaded areas, such as apartment house districts, commercial centers, etc.

2. Do not replace existing No. 6 secondaries unless the diversified secondary load exceeds in the order of 30 kva. per 1,000 ft. of secondary or local conditions require it.

3. Secondary neutrals should serve as a common neutral for primary and secondary on grounded neutral systems.

Banking of Secondaries

Banking of secondaries may be defined as connecting the end of one secondary to the end of an adjoining secondary. Banking should not be resorted to in a wholesale manner, but should be considered as a valuable tool which often can be used to advantage where local conditions make it advantageous. Secondary banking generally reduced the investment required to provide adequate service by (a) taking advantage of the diversity between the loads on adjoining secondaries, (b) decreasing the effect of unbalanced loads, (c) reducing the flicker caused by the starting of appliance motors.

A study of residential loads and diversities will show that the average load per customer decreases with the number of customers considered. Banking two secondaries increases the number of customers to be considered and decreases the average load per customer, with the result that much longer secondaries can be used without increasing the secondary voltage drop. This permits the use of larger transformers at greater spacing, with a consequent reduction in investment. This advantage of banking can best be appreciated after making a few voltage drop calculations for banked and unbanked secondaries. It is evident that banking will correct some of the bad effects of unbalanced loads and that the amount of correction will depend upon existing conditions.

The principal disadvantage of secondary banking is that all transformers whose secondaries are banked must be connected to the same primary phase. This contributes to the many difficulties experienced in balancing the primary loads. This disadvantage need not be serious if banking is used only where it is distinctly advantageous and if it is limited to two, three or, at most, four transformer installations.

Twenty-five-ampere secondary fuse cut-outs should be installed near the point of minimum current flow to prevent excessive blowing of transformer primary fuses due to secondary faults. The location of these secondary fuses is not critical.

Avoidance of Flicker

As more and more appliance motors come into use the flicker problem becomes more serious. Some engineers believe that the maximum lengths of secondaries should be limited by the amount of voltage fluctuation which might be created by motor starting. Such a policy limits the length of all secondaries, whether or not flicker is a serious problem. It is recommended that the design of transformer-secondary combinations be based upon voltage drops caused by ordinary residential loads, and that voltage flicker be taken care of as economically as possible in those cases where flicker causes customer complaints.

Objectionable voltage flicker can usually be corrected by one of the following methods:

1. Secondary banking.

2. Rearrangement of transformers to decrease the length of the secondary on which the objectionable flicker exists.

3. Use of auto-transformers at the end of the secondary.

Which of these methods is the most economical will depend upon local conditions. The different methods should be considered in the order given.

The economical sizes of distribution transformers for urban residential areas are usually 10, 15 and 25 kva. Smaller sizes of transformers are economical only for isolated secondaries, which must be considered individually.

Primary and Secondary Layouts

In general, the most economical and practical layout of primaries and secondaries is one having two-way secondaries parallel to and on the same poles with the primaries, having primaries on every avenue (or alley parallel to the avenue) and extended to cover the area by erecting short secondary branches to serve houses located on the side streets. Areas requiring new construction should be laid out with this in mind However, transformer-secondary design should make the most econom-

[*Continued on page 129*]

Power-Factor Testing of Transformer Insulation

Advanced methods developed for field testing transformer insulation—Multi-winding transformers included in technique to forestall insulation failures by an economical maintenance program

FRANK C. DOBLE and G. H. BROWNING, *Doble Engineering Company, Medford Hillside, Mass.*

THE importance of test methods to determine the condition of insulation has long been appreciated and engineers are in general agreement that the most practical non-destructive tests consist of determining power factor of the insulation at operating frequencies. Such tests have been more or less routine procedure in the laboratory for years. It is only recently, however, that test equipment has been available for determining the quality of insulation in the field. The necessity of measuring small quantities in high electrostatic fields, usually with one terminal of the insulation permanently grounded, makes the design of portable equipment for this purpose difficult.

After such test equipment had been developed it was necessary to conduct a large number of field tests to obtain a background of information which would permit the condition of insulation to be diagnosed intelligently because most of the apparatus tested, such as power transformers, instrument transformers, oil circuit breakers, bushings, etc., are non-homogeneous in their insulating structure and generally consist of various series and parallel combinations of fibrous materials, porcelain, insulating oils, wax compounds, etc. Thus, before it is possible to determine from the test data when insulation of such equipment is sufficiently deteriorated to warrant its reconditioning or replacement, there must be available the information obtained from much "failure experience" and from a large number of carefully analyzed test results.

This laborious testing and correlating has already been done and the art and technique of field testing has been materially advanced. In fact, new methods and varieties of tests have been instigated in order to segregate and determine the fault location. This is particularly true in the case of testing the insulation of power transformers—the subject of this paper.

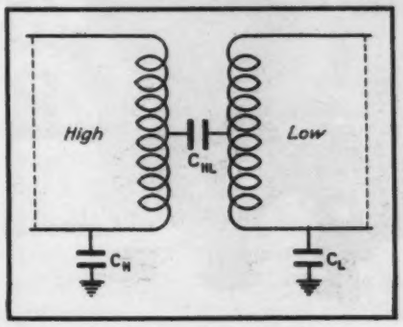


Fig. 1—Capacitances of two-winding transformers can be lumped

C_{HL} represents the insulation between the high and low-voltage windings. C_H represents the insulation of the high-voltage winding to ground, including, of course, the insulation of the two high-voltage bushings. C_L represents the insulation of the low-voltage winding to ground and includes the insulation of the low-voltage bushings.

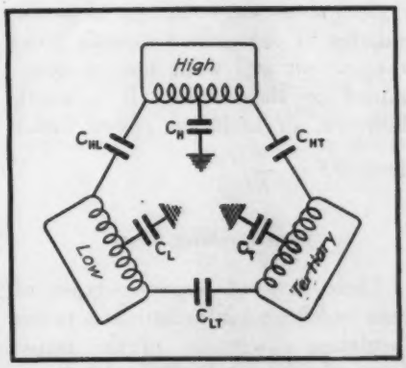


Fig. 2—Six readings segregate insulation capacitances in three-winding transformer

The insulations involved in power transformers may be divided into several parts. The capacitances in a two-winding power transformer may be "lumped" as indicated in Fig. 1.

In analyzing the condition of the transformer insulation, it is very helpful to have sufficient test data so that the characteristics of the various insulations may be segregated. It is also advisable to have a test procedure which will determine the condition of the bushings segregated from their associated windings. Given a power factor field tester, the question arises as to the technique for resolving the insulation of a transformer into its component parts. A description of one method is as follows:

The transformer must be taken out of service and the leads connected to the bushings removed. In order to eliminate the inductance of the windings the high-voltage and low-voltage windings are shorted. The transformer core and tank are assumed to be grounded. The first reading is obtained by applying the test voltage between the high-voltage winding and ground, having grounded the low-voltage winding. It is apparent that this will give data which is the sum of the insulations C_H and C_{HL}. A second reading is obtained by applying voltage between the low-voltage winding and ground, with the high-voltage winding grounded. It is obvious that this will give the insulation condition of C_L plus C_{HL}. If the high- and low-voltage windings are electrically connected together, and data are obtained by applying the test voltage between the high- and low-voltage windings as a whole, and ground, these data will be the insulation values of C_H plus C_L. Thus, we have three sets of test data and three separate insulations to be calculated, which, of course, may be readily accomplished.

Oils vs. Solid Insulation

This same test procedure, though more elaborate, can be applied to a three-winding transformer, as shown in Fig. 2, where there are three interwinding capacitances and three capacitances to ground. In this case it is necessary to take six readings in order to determine the six insulations.

From the standpoint of analyzing fault conditions, it is very advantage-

ous to be able to segregate the separate insulations involved, for in the case of some transformers the insulation between the high and low-voltage windings is mostly solid insulation acting as a barrier between the windings, while in the case of the insulation between the high- or low-voltage windings to ground usually a considerable portion of this is due to the oil in the transformer.

Therefore, if the power factors of C_H and C_L are higher than the power factor of C_{HL}, the first conclusion is that the oil in the transformer is deteriorated to such an extent that it has a power factor much higher than normal due to the moisture, sludge, acidity, etc.

Fig. 3—Typical test of a 220-kv. bushing installed on a 32,000-kva., three-winding transformer

However, if the power factor of either C_H or C_L is high in comparison with the other insulations, it indicates a bushing fault or a fault associated with that winding. Thus, knowing the type, construction, and something about the history of the transformer, a reasonably good analysis of fault conditions may be made without further labor or costs.

Shielded Apparatus Devised

In the above analyses it is assumed that the bushings associated with the high- and low-voltage windings have been or can be tested separately.

The Doble Engineering Company has developed field apparatus for determining the power factors of transformers as described above, also of the bushings associated with such transformers. The apparatus consists essentially of a voltage source so shielded as to allow only the current passing through the specimen under test to actuate the measuring instruments, which consist of a sensitive ammeter and a specially constructed low power factor wattmeter, the sensitivity of which is approximately 20 milliwatts full scale. This shielding system also protects the measuring apparatus against stray voltages which are induced in the various conductors when the tester is operated in electrostatic fields of high intensity. These electrostatic fields are due to the lines in the vicinity being energized, and in most cases cannot be avoided.

Sometimes the condition of the insulation is determined directly from the current and watts loss as determined by the meters. It is usual, however, to calculate power factor from $PF = \frac{W}{EI}$

Two Bushing Tests

There are two separate types of tests which give information as to the insulating conditions of the transformer bushings. If the bushings are of the draw-lead type the bushings themselves may be readily segregated from their associated windings by insulating the winding lead from the bushing cap for a few volts. Under this condition the test apparatus in Fig. 3 is arranged for measuring the current and watts loss in the bushing itself, regardless of the charging current and watts loss in the winding. This apparatus involves a current transformer especially shielded so that any current passing through the specimen under test energizes the secondary of the current transformer and thus actuates the meters. This current transformer is placed in the high-voltage lead of the voltage source and the shielding is so arranged that current taken to charge the capacitance of the transformer to ground does not flow through the primary of the current transformer and, therefore, does not cause a reading on the meters.

Tests Results Reviewed

In cases where the transformer bushings are not of the draw-lead type some information may be gained concerning their condition by applying another type of test. A series of metal bands is placed over the porcelain rain shield of the bushing. The bushing stud is grounded and the test voltage is applied between the metal band and ground. The charging current, watts loss and power factor of the insulation are then measured. Data thus obtained give an idea of the condition of the insulation in the upper half of the bushing. Used in connection with the standard power-factor tests described by I. W. Gross and H. E. Turner of the American Gas & Electric Company in ELECTRICAL WORLD, January 13–20, 1934, these data present a clear picture of the insulation of the bushing.

During the last four or five years a large amount of data have been collected on power transformers as well as the bushings therein. It may be of interest to review typical test results obtained on two- and three-winding transformers.

1. Typical normal transformers have values somewhat as follows:

Three-Winding Transformer

	Current Milli-amperes	Watts	Test Voltage Kv.	Power Factor at 20 Deg. C.
C_H	6.35	0.97	10	1.53
C_L	6.55	0.585	10	0.89
C_T	22.4	1.655	10	0.74
C_{HL}	19.25	1.125	10	0.58
C_{HT}	6.4	0.655	10	1.04
C_{LT}	6.2	0.63	10	1.02

Two-Winding Transformer

220/33 12,500 kva.

	Current Milli-amperes	Watts	Test Voltage Kv.	Power Factor at 20 Deg. C.
C_H	14.3	1.575	10	1.10
C_L	24.7	1.875	10	0.76
C_{HL}	20.7	1.775	10	0.86

The following data taken on a power transformer showed that C_H

[*Continued on page 128*]

4th Steam Station Cost Survey

By A. E. KNOWLTON
Associate Editor "Electrical World"

WITH a revival of power plant construction, managements of utilities are face to face with decisions which aim at getting the most return from the investments which growing loads necessitate. What boiler pressure, what size stations and units, what technical refinements are indicated by the experience of others to be desirable features of that new plant?

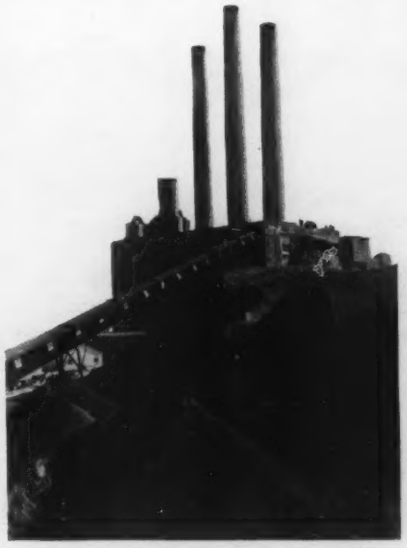
To offer timely answers to these and other equally important questions ELECTRICAL WORLD has assembled in this, its Fourth Steam Station Cost Survey, comprehensive data about 56 representative plants. The mere fact that this is nearly three times as massive an assembly of data as the previous one (October 9, 1937) attests the desire of the industry to have such a basic round-up made and interpreted. Without presuming to prejudge the trend of design, it cannot help guide the decisions which will be made on the stations to be built in the years immediately ahead. At the very least, it confirms in quantitative way by actual performance and cost data some of the trends which have been recognized in a general way.

For example, the trend is already away from large plants everywhere except in large metropolitan areas, where suitable plant sites and land costs are overriding determinants. This analysis shows that in addition to carrying all the detriments of mere bigness, they are at a disadvantage when measured from several angles of performance. When put on a comparable basis of operation the large plants show no dominant advantage in fuel economy. They show higher unit production cost and only slight advantage in over-all cost per kilowatt-hour.

Skepticism about the over-all benefits from high boiler pressures appears also to be well founded in that the heat consumption per kilowatt-hour is hardly much better than for the more moderate pressures and temperatures. Actual loading seems to offset the theoretical gains.

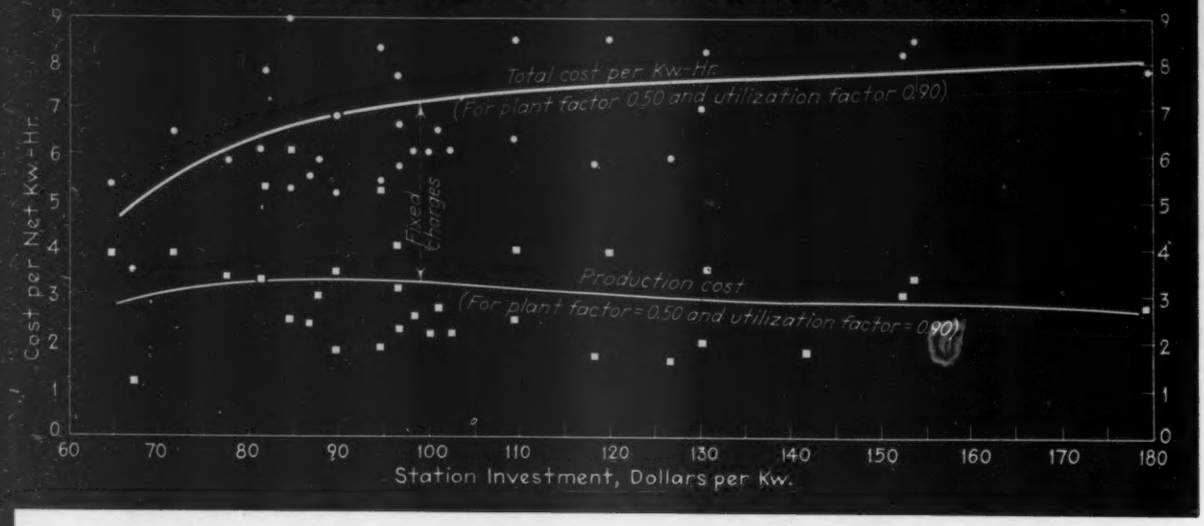
Nor does it seem to pay to spend a lot on refinements of a station to achieve high thermodynamic performance. In fact, the cheapest stations show up best when analyzed on a comparable basis of loading. From this standpoint an enlarged amount of capacity at relatively low unit investment would be an economic asset purely as a source of less expensive kilowatt-hours.

Evidence is ample that there are few stations which would not perform creditably if afforded the opportunity to function with good plant factor and good utilization factor. Much of the spread between stations otherwise comparable in size and design is traceable to the way in which they have to operate. Nevertheless, the deviations warrant critical analysis of pending designs to determine whether they promise to deliver the advantages manifested in this report by similar plants.



Not only the utility users but the designers and manufacturers of the wide array of steam plant equipment can find here plenty of guidance and inspiration for focussing on developments and applications which will be conducive to that primary objective of utility management — maximum fuel economy, minimum capital outlay and minimum operating and maintenance expense consistent with the cost of available fuel and with the loading anticipated for the station.

FIG. 1A—TOTAL ENERGY COST LEAST FOR STATIONS OF LOW UNIT COST


Total cost per Kw-Hr.
(For plant factor 0.50 and utilization factor 0.90)
Fixed charges
Production cost
(For plant factor = 0.50 and utilization factor = 0.90)
Cost per Net Kw.-Hr.
Station Investment, Dollars per Kw.

Economics of Station Design and Use

Least costly designs appear advantageous in analysis on comparable basis — Operations concentrate on plants with best production cost and highest unit investments

ANALYSES of station investments and total costs of output per kilowatt-hour at the bus show fairly conclusively that it does not pay to build plants of high unit cost. The urge is always present to elaborate the design for the sake of improving fuel efficiency. But taking man-power, maintenance and fixed charges into account, it appears (Fig. 1-A) that the less costly designs, while entailing somewhat higher production costs, do reduce fixed charges enough more to result in lower energy cost ready for distribution. In fact, the very cheapest plants tend to make the best showing.

This can hardly be inferred from the data for actual operation because plant loading varies enough to obscure the tendency. However, when all plants are analyzed on the common basis of 50 per cent plant factor

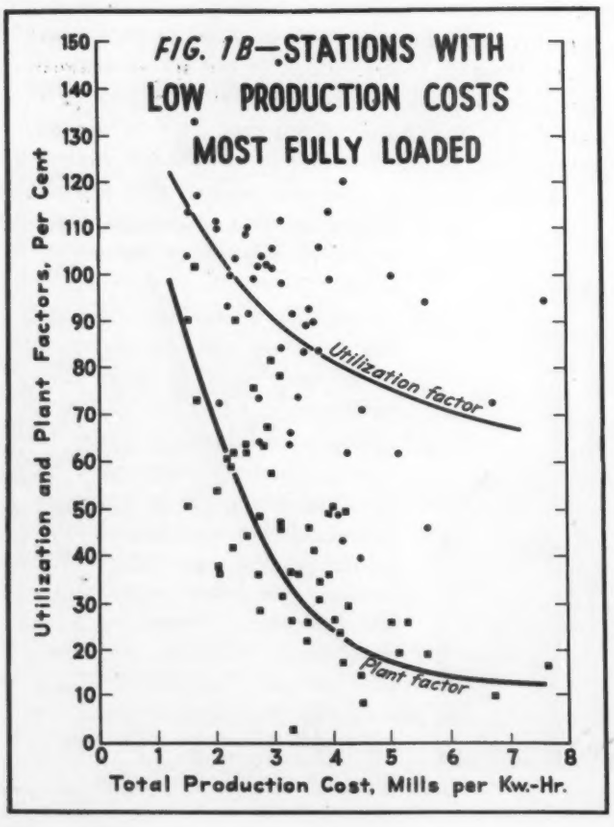


FIG. 1B—STATIONS WITH LOW PRODUCTION COSTS MOST FULLY LOADED
Utilization and Plant Factors, Per Cent
Utilization factor
Plant factor
Total Production Cost, Mills per Kw.-Hr.

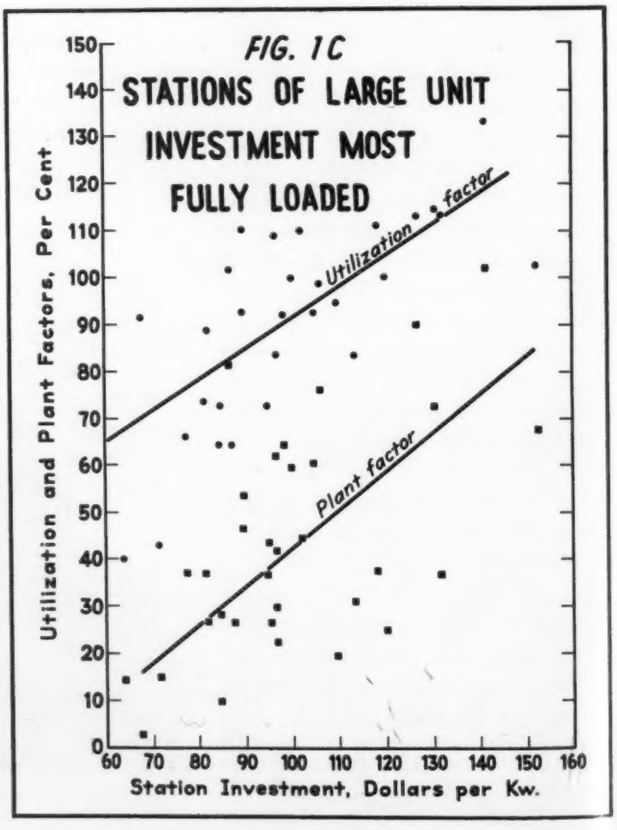


FIG. 1C
STATIONS OF LARGE UNIT INVESTMENT MOST FULLY LOADED
Utilization factor
Plant factor
Utilization and Plant Factors, Per Cent
Station Investment, Dollars per Kw.

and 90 per cent utilization factor* it is revealed that the cheaper plants apparently produced energy more cheaply. In this respect the data confirm the trend away from refined designs. Large plants do present slightly lower over-all costs per kilowatt-hour, but they are progressively out of favor for other reasons best typified by the "all in one basket" adage.

Exigencies of operation under prevailing conditions of system loading and capacity are reflecting some operating results that appear somewhat contradictory. First, it is evident (Fig. 1-B) that the stations with the lowest production cost are being loaded both most extensively (highest plant factors) and most intensively (highest utilization factors). The extensive loading for long hours is, of course, logical, but it would seem more logical to use the poorer plants on the peaks to relieve the efficient plants. As capacity expands, it is likely that this logical procedure will be resumed.

An apparently contradictory trend is observed in the extent to which inexpensive and expensive plants are loaded. Here the most expensive plants are the ones loaded most steadily and most likely to carry peaks in excess of rating (Fig. 1-C). This may be explained by the desire, consistently with the manner in which each plant has to be operated in conjunction with others on the same or adjacent systems, to realize on the heavier investments. But, again, it does not appear that this would be advantageous if all plants could be loaded more nearly equally because, in that case, the cheaper plants show up best in terms of mills per kilowatt-hour.

On the whole, the stations in the report show plant factors averaging better than 40 per cent and utilization factors better than 80 per cent (Fig. 1-D). The smallest plants were crowded for output of kilowatt-hours much more than the largest ones and the extremes in size more than the plants of intermediate rating. Utilization of capacity on peaks was also more for the largest stations than for medium-sized ones, but only up to about 90 per cent of capacity.

*Investment per kilowatt and fuel cost per kilowatt-hour are assumed constant; total of other production expenses is assumed fixed, but divided among 4,380 hours use (50 per cent plant factor) of a station with rating 100/90ths of the one-hour peak reported for the station (see page [illegible] for details).

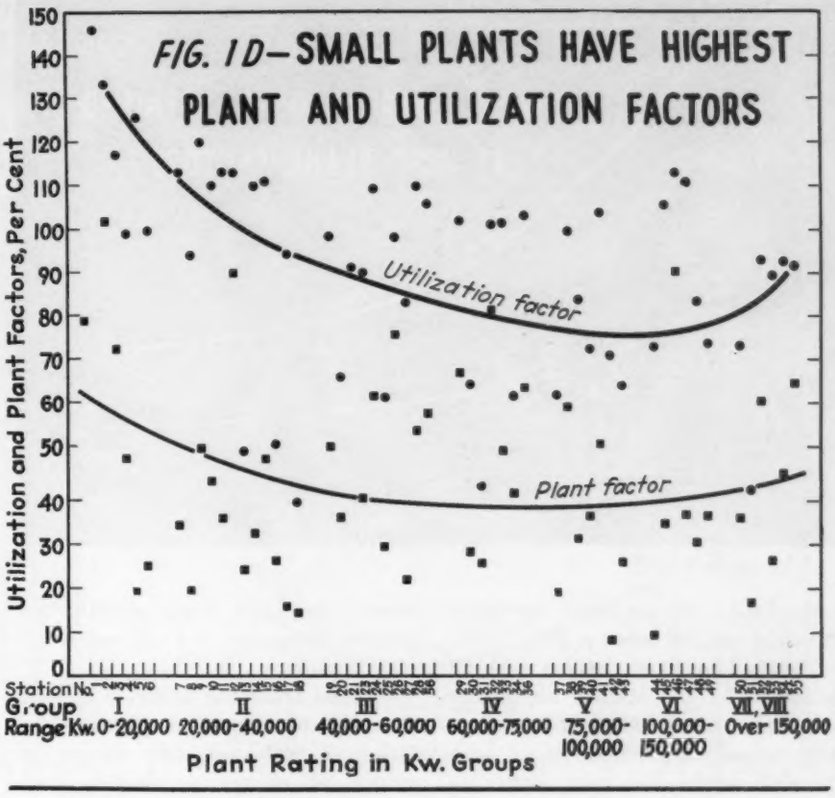
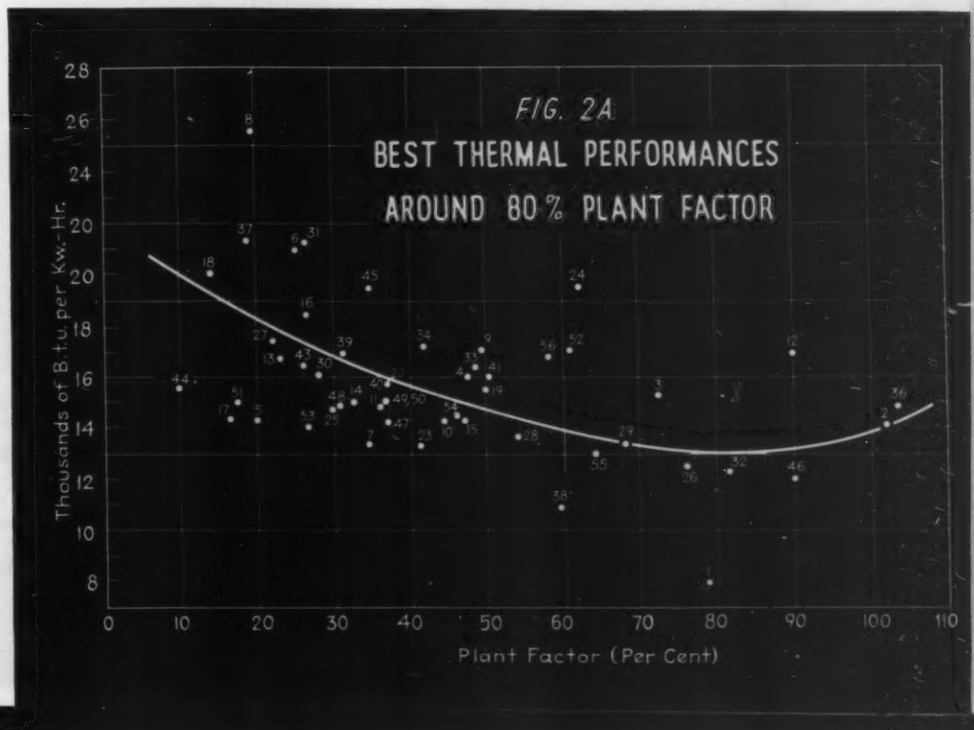


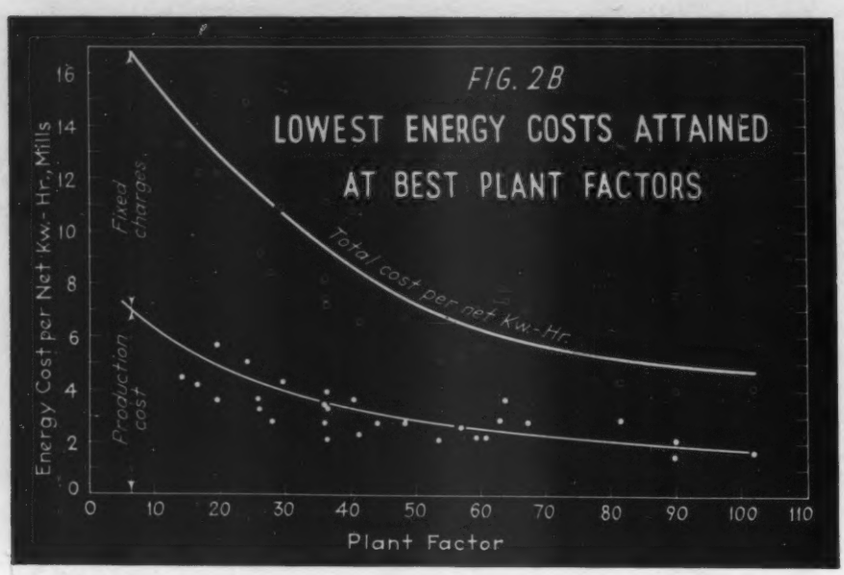
FIG. 1D—SMALL PLANTS HAVE HIGHEST PLANT AND UTILIZATION FACTORS
Utilization and Plant Factors, Per Cent
Utilization factor
Plant factor
Station No.
Group I II III IV V VI VII, VIII
Range Kw. 0-20,000 20,000-40,000 40,000-60,000 60,000-75,000 75,000-100,000 100,000-150,000 Over 150,000
Plant Rating in Kw. Groups

Power Generation Costs

Fixed charges exceed production costs slightly at all plant factors — Medium-sized stations show lowest total energy cost at bus — Wide variation attributable to operating limitations

FROM the standpoint of fuel consumption alone it appears that best results for the average or typical station are obtained at about 80 per cent plant factor (Fig. 2-A). But from the more significant index of total cost of energy production it appears that the higher the plant factor





(even up to 100 per cent) the lower the total cost of energy (Fig. 2-B). Of course, the fixed charges once established by the station investment are diluted more and more in allocation to each kilowatt-hour as each kilowatt works for more hours in turning out energy. And quite as naturally, the total cost of fuel, wages and maintenance per kilowatt-hour decrease with increased output, because wages and maintenance do not increase linearly with output as does fuel use.

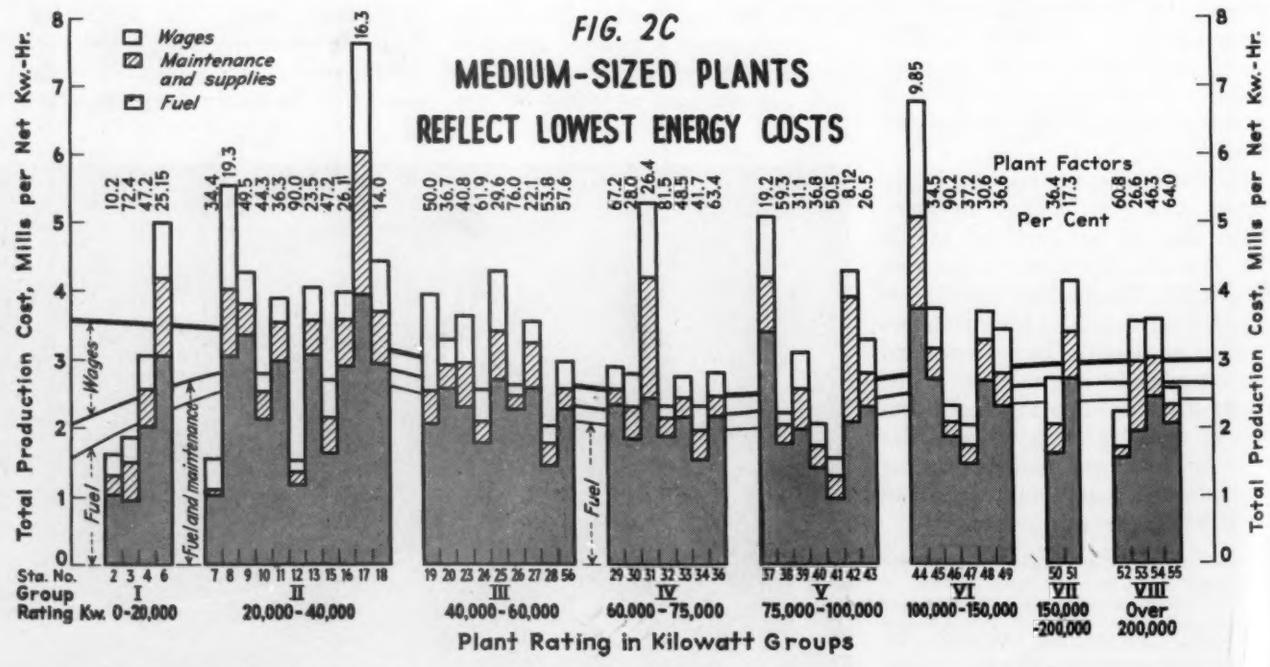
Production cost and fixed charges prove to be nearly equal components of total energy cost whatever the plant factor, the latter being slightly the greater component for all values of plant factor.

Viewed from the angle of station size, the medium-sized plants (60,000 to 75,000 kw.) show the lowest values of energy production cost (Fig. 2-C). It is presumably the higher cost of fuel delivered at large metropolitan stations which, offsetting the superior thermal performance (Fig. 3-C) in those large plants, offers medium-sized stations their opportunity to make a slightly better showing of production cost. Exceptionally low unit fuel cost is reflected at two of the smallest plants, and this is attributable to low cost of fuel per B.t.u. (see Table II).

Station staff wage totals per kilowatt-hour are two or three times as great for the Group I plants as for all the others, and this is perhaps not strange. With one exception (Plant No. 2) the total production cost is about inverse to the plant factors, as one would expect (Fig. 2-B). Otherwise station wages, maintenance and fuel retain a remarkably consistent trend toward one another for all but these smallest stations. The considerable departures shrink materially, however, when the plant and utilization factors are converted to a common basis, as in Fig. 5-B.

Wages and maintenance seem throughout to be affected more adversely by low plant factor than is the cost of full consumed per net kilowatt-hour. For the lowest values of plant factor they tend to combine to a total roughly equal (in magnitude) to fuel cost per net kilowatt-hour.

On the whole, the best performance lies at 2½ mills total cost at the bus and this is for the medium-sized plants. Almost the best individual performance (1.68 mills) was, however, for a small plant operated at 90 per cent plant factor. On the other hand, six of the 56 stations had total production costs in excess of 5 mills per kilowatt-hour; their plant factors were, however, low, ranging from 9.85 to 26.4 per cent.



Station Fuel Economies

Unit investments up and B.t.u. down where fuel costs are high — Actual operating conditions mask theoretical advantages of higher steam conditions — Superposition largely a matter of conserved investment

FUEL COSTS for this group of stations run from slightly less than 6 to as high as 20 cents per million B.t.u.; the majority of the stations, however, fall between 9 and 17 cents with a sizable group between 13 and 16 cents (Fig. 3-A). As might be expected, the heat efficiency of the station attained in the design is better the higher the cost per heat unit. It is quite evident that more dollars must be invested to attain better fuel economy in areas where fuel is relatively expensive. Also, unit investment is least in the middle range of fuel cost.

Plants employing boiler pressures in the 1,200 to 1,450-pound class show in actual performance some 5 or 6 per cent better thermal economy than the average of those in the 600 to 900-pound class (Fig. 3-B). The latter, in turn, prove in actual service to be about 20 per cent more economical of heat units than the plants with pressures around 400 pounds. It also appears that the plants with superposed units are no better on the average than those with straight condensing units.

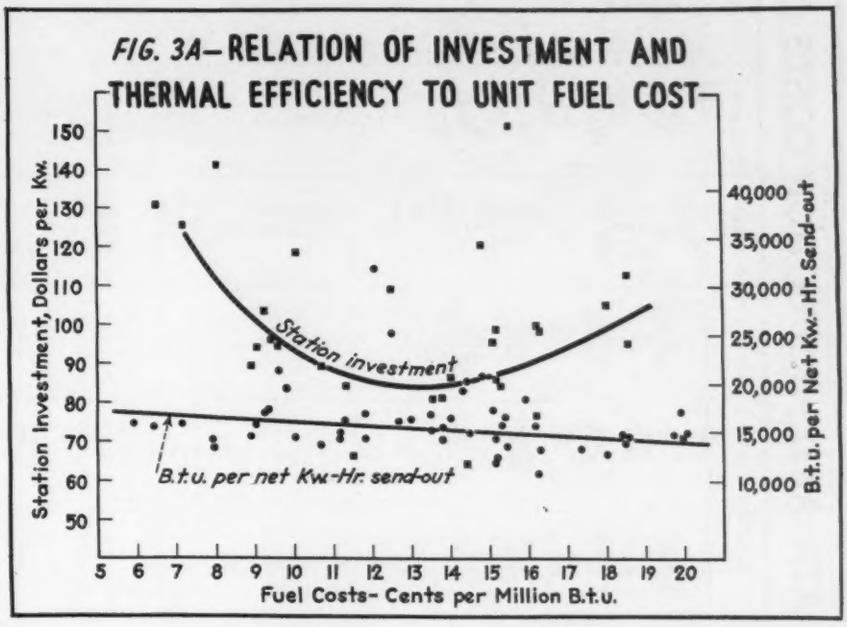


FIG. 3A—RELATION OF INVESTMENT AND THERMAL EFFICIENCY TO UNIT FUEL COST
Station Investment, Dollars per Kw.
B.t.u. per Net Kw.-Hr. Send-out
Station investment
B.t.u. per net Kw.-Hr. send-out
Fuel Costs- Cents per Million B.t.u.

This merely bears out the prevailing objective of superposition, namely, to utilize existing sites and plant buildings and condensing water facilities to develop additional capacity and only secondarily to attain higher thermal economy. The latter

[*Continued on page 64*]

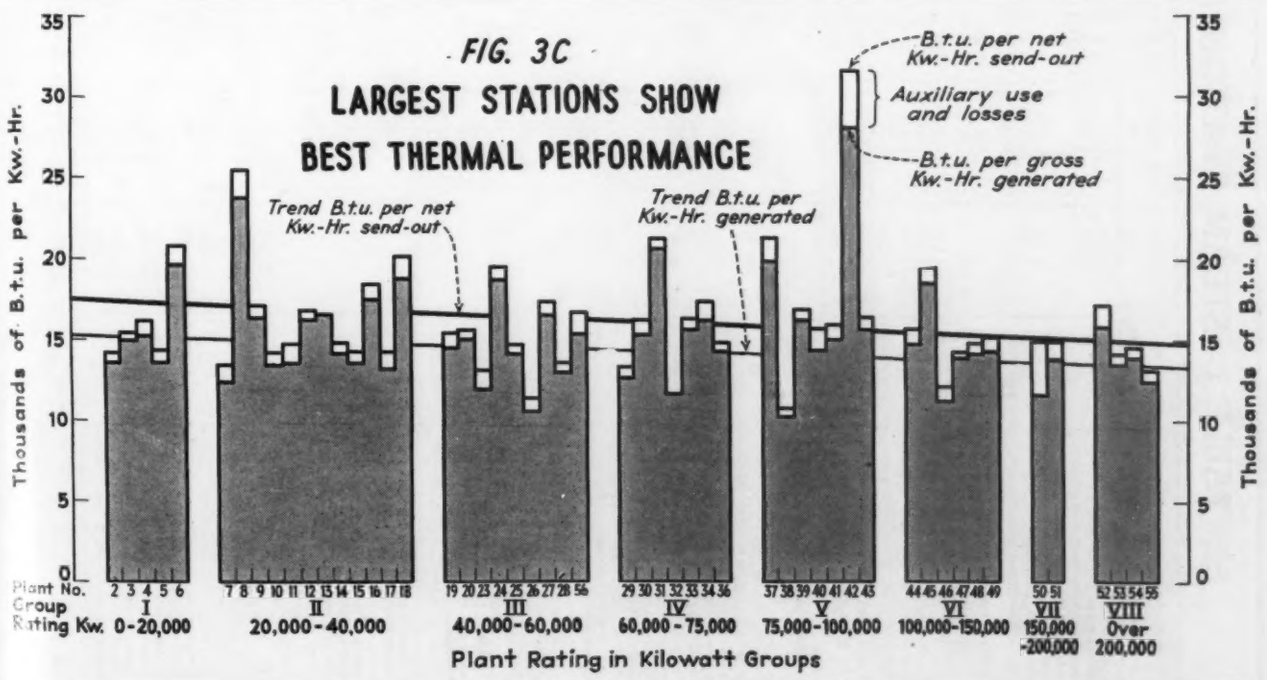


TABLE I—STEAM STATION EQUIPMENT DATA AND PRODUCTION COSTS (1938)

Stations*	1	2 (N)	3 (R)	4	5 (S)	6	7	8	9	10 (A)	11 (T)	12	13	14
Rating group (see footnote)	I	I	I	I	I	I	II	II	II	II	II	II	II	II
Normal function (see footnote)	(f)	(c)	(d)	(a) (e)	(e)	(d)	(c) (d)	(a) (b) (f)	(d) (e)	(c)	(c)	(a)	(d)	(d)
Number of units, condensing	1	1	1	1	1	2	1	4	2	2	1	3	4	1
Superposing or non-condensing	0	0	0	0	0	0	0	0	0	0	.....	0	0	0
Boiler units, number	2	3	2	1	1	2	2	7	3	2	2	6	8	1
Size (lb./hour)	200,000	10,012 sq. ft.	150,000	200,000	325,000	150,000	160,000	26,000–200,000	150,000–165,000	200,000	300,000	75,000	25,000–120,000	312,000
Steam pressure, boiler, lb	450	400	400	425	450	325	675	270–193	400	525	650	275	200–440	840
Temperature deg. F	750	696	720	750	775	700	835	577–468	750	825	825	675	550–800	825
Cooling water, summer, winter, deg. F	.....	78–54	83–41	69–40	72–33	75–33	98–44	80–50	100–60	79–39	53–39	89.30–62.8	90–33	84–45
Ave. vacuum (in.)	.....	28.60	27.57	29.27	28.75	28.5	28.76	29.70	27.11	23.28	0.88 abs.	27.92	28.8	28.58
No. in station shift—oper.-maint.[1]	3–0	3–9 Tot.	5–5	7.5–2.2	43 T–3 T	4–4	26 T–7 T	7–6	6–3	8–7 tot.	5–4 T	25 T–13 T	5–4	8–2
Plant structure area, acres	.....	0.34	0.20	0.2	0.35	0.25	0.34	2	0.28	0.38	16 (?)	.68	3.765	0.20
Fuel storage area, acres	1,100 bbl.	.....	3.50	1	0.15	2	3,000 bbl.	0.40	15–25 M bbl.	0.75	In Plant	10,000 bbl.	0.66	0.75
Fuels used in plant	Gas	Gas	Coke	Coal	Coal	Coal	Gas	Oil-Gas	Oil-Gas	Coal-Oil	Coal	Oil-Gas	Coal	Coal-Oil
Station Details:														
Stokers	.....	.....	.....	✓	.....	.....	.....	.....	.....	.....	.....	.....	✓	.....
Pulverized fuel	.....	.....	✓	.....	✓	✓	.....	.....	.....	✓	✓	.....	✓	✓
Oil	.....	.....	.....	.....	.....	.....	.....	✓	.....	.....	.....	✓	.....	.....
Gas	✓	✓	.....	.....	.....	.....	✓	✓	✓	.....	.....	✓	.....	.....
Air preheating	✓	✓	✓	.....	.....	✓	✓	.....	.....	✓	✓	.....	✓	✓
Steam reheating	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Economizers	.....	.....	.....	.....	✓	.....	.....	.....	✓	✓	✓	.....	✓	✓
Waterwall furnaces	✓	.....	✓	✓	✓	✓	✓	✓	✓	✓	✓	.....	✓	✓
Stage bleeding	✓	✓	✓	✓	✓	✓	✓	.....	✓	✓	✓	✓	✓	✓
Duplicate feed pumps	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Duplicate circulating pumps	.....	.....	.....	.....	.....	.....	.....	✓	✓	✓	.....	.....	✓	✓
Generator air coolers	✓	✓	.....	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Generator hydrogen cooler	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Automatic combustion system	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	✓	✓
Water cooling tower	.....	.....	.....	.....	.....	.....	✓	✓	.....	.....	.....	.....	.....	.....
Outdoor switchyard	.....	.....	✓	✓	.....	✓	✓	✓	✓	✓	✓	.....	✓	.....
Fuel Data for 1938:														
Total fuel used:														
Short tons of coal	.....	.....	55,081	46,696	12,955	33,000	.....	.....	.....	54,442	49,988	.....	54,500	37,004
Barrels of oil	.....	.....	.....	.....	.....	.....	.....	234	40,151	445	.....	74.69	.....	16,362
M cu.ft. of gas	2,079,596	1,594,753	.....	.....	.....	.....	785,812	1,064,677	1,551,969	.....	.....	3,873,209	.....	.....
Heat value as fired, B.t.u.:														
Coal per lb	.....	.....	14,716	12,460	13,756	13,044	.....	.....	.....	14,305	13,412	.....	11,430	13,800
Oil per gallon	.....	.....	.....	.....	.....	.....	.....	153,600	147,500	.....	.....	143,070	.....	138,000
Gas per cu.ft	1,000	1,155	.....	.....	.....	.....	1,032	1,000	1,062	.....	.....	1,000	.....	.....
Cost Delivered, Dollars:														
Coal per ton	.....	.....	1.90	3.16	5.08	3.86	.....	.....	.....	4.32	5.294	.....	3.50	3.14
Oil per barrel	.....	.....	.....	.....	.....	.....	.....	2.07	1.53	2.30	.....	1.28	.....	2.50
Gas per M cu.ft	0.14	0.091	.....	.....	.....	.....	0.086	.125	0.20	.....	.....	.07204	.....	.....
Ash content, per cent	.....	.....	0.8	7.3	5	5	.....	.....	.....	3.91	4.42	.....	10.	7.5
Moisture, per cent	.....	.....	7.4	7.7	5	6.30	.....	.....	.....	4.46	4.61	.....	12.	2.5
Operating Costs (Mills per net kw.-hr.):														
Fuel	.....	1.117	0.960	2.029	.....	3.090	1.010	3.10	3.386	2.140	2.992	1.218	3.080	.....
Wages and superintendence	.....	0.209	0.600	0.588	.....	1.130	0.350	0.18	0.451	0.413	0.558	0.179	0.550	.....
Water, lubrication and supplies	.....	0.077	0.040	0.084	.....	0.110	0.050	0.20	0.210	0.064	0.057	0.046	0.108	.....
Maintenance and repairs:														
Buildings and structures	.....	0.058	0.034	0.054	.....	0.110	.....	.....	0.047	0.029	0.029	.....	0.022	.....
Boiler plant	.....	0.135	0.093	0.023	.....	0.230	0.060	0.48	0.045	0.101	0.058	.....	0.170	.....
Fuel handling	.....	.....	0.065	0.029	.....	0.080	.....	.....	0.002	0.027	0.043	.....	0.060	.....
Prime movers and auxiliaries	.....	0.047	0.030	0.042	.....	0.100	0.100	.....	0.103	0.033	0.141	.....	0.029	.....
Electrical equip. and misc	.....	0.039	0.026	0.024	.....	0.020	.....	.....	0.040	0.020	0.020	.....	0.030	.....
Supervision and engineering	.....	.....	0.037	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.026	.....
Total maint. and repairs	.....	0.278	0.285	0.384	.....	0.670	.....	1.40	0.238	0.210	0.291	0.071	0.330	.....
Total oper. and maint. (ex. fuel)	.....	0.564	0.910	1.062	.....	1.910	0.590	2.50	0.899	0.687	0.906	0.296	0.990	.....
Total production (no fixed charges)	.....	1,680	1.874	3.092	.....	5.000	1.600	5.60	4.286	2.827	3.898	1.514	4.070	.....
Total gross generation, millions kw.-hr	34.42	132.98	108.68	76.63	26.33	44.10	69.42	44.99	118.89	116.62	95.35	236.74	.....	85.51
Total net generation, millions kw.-hr	28.43	129.96	105.43	72.69	24.78	41.18	63.67	41.73	111.34	109.75	88.41	229.19	61.83	80.60
Max. load, kw., 30-min. peak	7,300	20,100	17,568	18,500	25,200	20,000	26,000	23,200	33,100	33,000	33,750	34,100	14,520	33,000

[*Continued on page 58*]

[Continued on page 581]

TABLE II—STEAM STATION UNIT INVESTMENT COST, TOTAL POWER COST AND PERFORMANCE (1938)

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Unit Investment Cost, Dollars per kw.:														
Land	.....	.....	2.00	.....	.....	3.14	.....	1.50	.....	1.42	5.17	6.88	.....	.....
Buildings and foundations	.....	.....	32.00	.....	.....	37.02	.....	13.48	.....	21.25	33.70	.....	.....	.....
Condensing supply works	.....	.....	.....	.....	.....	.....	.....	5.94	.....	4.45	7.28	.....	.....	.....
Fuel-handling, storage	.....	.....	8.41	.....	.....	.....	.....	4.31	.....	2.50	3.23	.....	.....	.....
Ash handling	.....	.....	2.23	.....	.....	.....	.....	.02	.....	0.90	0.77	.....	.....	.....
Boiler plant	.....	.....	20.20	.....	.....	40.58	.....	14.23	.....	22.30	29.68	.....	.....	.....
Draft system	.....	.....	6.13	.....	.....	.....	.....	3.74	.....	3.98	2.43	.....	.....	.....
Feedwater system	.....	.....	3.11	.....	.....	.....	.....	1.72	.....	3.73	2.95	.....	.....	.....
Piping system	.....	.....	7.67	.....	.....	.....	.....	12.38	.....	7.53	8.67	.....	.....	.....
Turbine foundations	.....	.....	.....	.....	.....	.....	.....	1.24	.....	1.09	.....	119.83	.....	.....
Heat recovery apparatus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Generator air (or H) coolers	.....	.....	0.52	.....	.....	.....	.....	.41	.....	.....	.....	.....	.....	.....
Turbo-generators	.....	.....	25.20	.....	.....	27.07	.....	32.60	.....	18.82	22.19	.....	.....	.....
Turbine auxiliaries	.....	.....	2.18	.....	.....	.....	.....	2.82	.....	0.64	0.13	.....	.....	.....
Main condensers	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.36	.....	.....	.....	.....
Switchgear and station wiring	.....	.....	9.43	.....	.....	10.27	.....	12.47	.....	9.12	12.05	.....	.....	.....
Miscellaneous	.....	.....	11.20	.....	.....	2.44	.....	2.81	.....	.....	3.23	.....	.....	.....
Total station	.....	141.77	130.28	.....	.....	120.60	.....	109.68	.....	101.99	131.49	126.73	.....	.....
Outdoor switching equipment	.....	.....	14.25	.....	.....	13.36	.....	.....	.....	13.35	8.70	.....	.....	.....
Total station and switchyard	.....	141.77	144.53	.....	.....	133.96	.....	.....	.....	115.34	140.19	.....	.....	.....
Cost of Energy (Mills per net kw.-hr.):														
Fixed charges at 15 per cent	.....	2.45	3.08	.....	.....	9.80	.....	9.65	.....	4.74	7.14	2.49	.....	.....
Production charges	3.09	1.68	1.87	3.09	.....	5.00	.....	5.60	4.20	2.83	3.90	1.51	4.07	.....
Total cost, actual	.....	4.13	4.95	.....	.....	14.80	.....	15.25	.....	7.57	11.04	4.00	.....	.....
Fixed charges at 90 utilization factor	.....	4.75	4.95	.....	.....	4.65	.....	3.65	.....	3.97	4.83	4.32	.....	.....
Produc. charges at 50 plant factor	.....	1.92	2.08	.....	.....	3.91	.....	4.00	.....	2.65	3.47	1.64	.....	.....
Comparative cost	.....	6.67	7.03	.....	.....	8.56	.....	7.65	.....	6.58	8.30	5.96	.....	.....
Station Performance in 1938:														
Millions B.t.u. used	2,079,596	1,840,000	1,620,000	1,160,000	357,000	860,000	850,000	1,066,000	1,898,000	1,558,000	1,315,000	3,877,000	1,240,000	1,110,000
Fuel cost, cents per million B.t.u.	14	7.90	6.45	12.7	18.45	14.8	7.95	12.5	19.9	15.19	19.70	7.19	15.4	11.2
B.t.u. per net kw.-hr. send-out	7,850	14,179	15,375	16,007	14,382	20,940	13,374	25,600	17,040	14,215	14,860	16,901	16,700	14,964
B.t.u. per gross kw.-hr. generated	6,400	13,600	14,900	15,200	13,500	19,600	12,300	23,800	16,300	13,380	13,600	16,330	16,700	14,100
Average boiler efficiency, per cent.	83.5	79.05	85.1	74.22	79.87	84.6	83.5	70	81.6	84.7	83.12	81.1	76.7	86.5
Thermal efficiency, net basis	43.2	24.1	22.2	21.4	23.8	16.35	25.5	13.4	17.2	24.1	23.0	20.2	20.5	22.9
Employees per 1,000 kw. per day	1.78	1.20	1.33	1.54	2.30	1.20	1.43	1.58	.98	1.33	0.63	1.26	.90	1.00
Plant factor, annual, per cent	78.7	1.02	72.4	47.2	19.85	25.15	34.4	19.3	49.5	44.3	36.3	90.0	23.5	32.5
Utilization factor, annual, per cent.	146	133	117	98.7	126	100	113	94.2	120	110	113.5	113.6	48.7	110
Station Unit Space Factors:														
Boiler room, cu.ft. per kw	20.20	20.90	28.70	1.84	23.15	7.98	4.83	19.40	8.52	21.30	28.50	19.50	38.00	17.90
Turbine room, cu.ft. per kw	7.02	11.10	14.13	3.97	29.85	16.20	4.72	15.30	10.05	14.00	23.30	16.35	20.40	4.93
Switchhouse, cu.ft. per kw	1.40	1.90	.....	.....	7.50	4.23	0.55	0.84	0.61	.....	1.48	4.20	7.93	.....
Fuel preparation room, cu.ft. per kw	.....	.....	.....	.....	0.89	2.34	.....	.....	.....	4.47	0.27	.....	.....	.....
Station site, sq.ft. per kw	.....	0.99	0.58	0.45	0.76	0.55	0.64	3.54	0.44	0.55	23.27	0.99	0.55	0.29
Fuel storage area, sq.ft. per kw	.....	.....	10.16	2.33	0.33	4.36	.....	7.07	.....	1.09	.....	.....	0.96	1.09
Switchyard, sq.ft. per kw	.....	.....	5.65	.02	.....	2.24	16.20	0.64	.99	1.83	0.68	.....	0.17	.....
Storage capacity, tons per kw	0.22 bbl	.....	3.00	0.43	0.08	2.50	0.13 bbl	0.20	0.91 bbl	0.27	0.09	0.33 bbl	0.13	0.25

* Letters in ( ) show listing of stations in Third Steam Station Cost Survey.

Rating groups, kw.: I, to 20,000; II, 20,000 to 40,000; III, 40,000 to 60,000; IV, 60,000 to 75,000; V, 75,000 to 100,000; VI, 100,000 to 150,000; VII, 150,000 to 200,000; VIII, over 200,000.

Normal function: (a) Normal system stations; (b) Normal distribution station; (c) Normal transmission; (d) Normal base load; (e) Standby; (f) Power and district steam.

[1] Some reports gave total number of employees on maintenance, usually working in only one shift. Numbers thus reported are marked T.

[2] Units of 200 cu.ft. and B.t.u. per unit.

[Continued on page 59]

TABLE I—STEAM STATION EQUIPMENT DATA AND PRODUCTION COSTS (1938)—(Continued)

Stations*	15	16	17	18	19	20	21 (L)	22	23 (E)	24	25	26	27 (D)	28 (H)
Rating group (see footnote)	II	II	II	II	III	III	III	III	III	III	III	III	III	III
Normal function (see footnote)	(c) (d)	(b)	(e)	(a)	(a)	(a) (c)	(e)	(a)	(a)	(a)	(a) (d)	(d)	(a)	(e)
Number of units, condensing	1	5	3	4	4	2	1	1	2	5	4	1	2	1
Superposing or non-condensing	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Boiler units, number	2	8	13	6	10	2	2	1	3	15	8	2	3	2
Size (lb./hour)	200,000	425,560	25,000–37,000	45,000	50,000–140,000	184,000	425,000	275,000	279,000	16,000–300,000	68,000–130,000	250,000	250,000–300,000	.....
Steam pressure, boiler, lb	750	200–400	195–500	300	860	432	425	875	1,400	200–825	250–640	1,350	425	475
Temperature deg. F	825	500–700	640–750	615	825	715	650	910	750	500–825	590–825	750	720	725
Cooling water, summer, winter deg. F	80–49	78–57	75–49.4	78–35	88–62	75–55	50–60	.....	72–38	75–41	63–43	Ave. 54	76–74	80.6–48.4
Ave. vacuum (in.)	28.64	28.45	1.16	1.5	27.7	1.1	29.3	.....	28.91	23.65	28.93–28.77	1.093	1.32	23.47
No. in station shift—oper.-maint.[1]	13–11 T	8–6	12–5 T	6–3	8–33 T	6–18	7–7	.....	10–24 tot.	12–30 T	75 T	.....	8–25 T	19–2
Plant structure area, acres	0.16	0.67	0.9	1.1	5	0.476	21.50 (?)	.....	5.7 (?)	0.874	15	.....	0.42	.....
Fuel storage area, acres	13,100 bbl.	.....	2.8	1	2	10,000 bbl.	.....	.....	1.6	1.25	1.3	.....	3 Tanks	120,000
Fuels used in plant	Oil-Gas	Oil	Coal	Coal	Oil	Oil-Gas	Oil-Gas	Gas	Coal-Oil	Coal	Coal-Oil	Coal	Gas	Coal
Station Details:														
Stokers	.....	.....	√	√	.....	.....	.....	.....	.....	√	√	.....	.....	.....
Pulverized fuel	.....	.....	√	.....	.....	.....	.....	.....	√	√	√	√	.....	√
Oil	.....	√	.....	.....	√	.....	√	.....	.....	.....	√	.....	√	.....
Gas	√	.....	.....	.....	.....	√	√	√	.....	.....	.....	.....	√	.....
Air preheating	√	.....	√	.....	√	√	.....	√	√	√	√	√	√	√
Steam reheating	.....	.....	.....	.....	.....	.....	.....	.....	√	.....	.....	.....	.....	.....
Economizers	√	.....	√	√	.....	.....	.....	√	√	.....	√	√	.....	.....
Waterwall furnaces	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Stage bleeding	√	√	√	√	√	√	√	√	√	.....	√	√	√	√
Duplicate feed pumps	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Duplicate circulating pumps	√	√	√	√	√	√	√	.....	√	√	√	√	√	.....
Generator air coolers	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Generator hydrogen cooler	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Automatic combustion system	.....	.....	√	√	√	√	.....	.....	.....	√	√	√	.....	√
Water cooling tower	.....	.....	.....	.....	.....	.....	.....	√	.....	.....	.....	.....	.....	.....
Outdoor switchyard	√	.....	.....	.....	√	√	.....	√	√	√	√	.....	√	√
Fuel Data for 1938:														
Total fuel used:														
Short tons of coal	.....	.....	34,550	32,235	.....	.....	.....	.....	78,401	193,867	71,495	153,955	.....	151,868
Barrels of oil	1,694	225,858	.....	.....	421,287	5,893	14,595	.....	1,876	.....	3,968.43	.....	.....	.....
M cu.ft. of gas	1,659,510	.....	.....	.....	.....	1,916,662	254,349	.....	.....	.....	.....	.....	1,839,780	.....
Heat value as fired, B.t.u.:														
Coal per lb	.....	.....	11,440	13,482	.....	.....	.....	.....	13,584	12,750	13,871	13,849	.....	12,133
Oil per gallon	145,400	151,255	.....	.....	150,000	131,300	148,800	.....	.....	.....	134,400	.....	.....	.....
Gas per cu.ft	1,048	.....	.....	.....	.....	1,074	1,200	.....	.....	.....	.....	.....	1,055	.....
Cost Delivered, Dollars:														
Coal per ton	.....	.....	2.71	3.90	.....	.....	.....	.....	4.09	2.48	5.09	5.01	.....	2.59
Oil per barrel	0.96	1.005	.....	.....	.876	2.20	.098	.....	2.19	.....	2.22	.....	.....	.....
Gas per M cu.ft	0.13	.....	.....	.....	.....	0.168	0.123	.....	.....	.....	.....	.....	.159	.....
Ash content, per cent	.....	.....	12.0	9.82	.....	.....	.....	.....	8.89	11.5	5.8	6.56	.....	12.34
Moisture, per cent	.....	.....	7.96	1.23	.....	.....	.....	.....	3.56	3.9	5.68	4.78	.....	5.43
Operating Costs (Mills per net kw.-hr.):														
Fuel	1.640	2.900	3.960	2.910	2.160	2.600	1.190	.....	2.270	1.760	2.734	2.250	2.618	1.450
Wages and superintendence	0.520	0.700	2.100	0.830	.374	0.300	1.530	.....	0.630	0.348	0.699	0.223	0.634	0.312
Water, lubrication and supplies	0.200	0.100	0.390	0.120	0.94	0.100	0.120	.....	0.170	0.069	0.071	.....	0.065	0.024
Maintenance and repairs:														
Buildings and structures	0.130	.....	0.100	0.070	.070	.....	.....	.....	0.090	.....	0.171	.....	0.032	0.066
Boiler plant	0.100	0.100	0.500	0.240	.150	0.100	.....	.....	0.320	0.171	0.304	.....	0.096	0.065
Fuel handling	.....	.....	0.190	0.140	.....	.....	.....	.....	0.080	.....	.....	.....	0.001	0.021
Prime movers and auxiliaries	0.050	0.200	0.220	0.140	.060	0.100	.....	.....	0.090	0.196	0.244	.....	0.044	0.060
Electrical equip. and misc	0.100	.....	0.210	0.020	0.40	0.100	.....	.....	0.020	.....	0.053	.....	0.018	0.014
Supervision and engineering	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.036	.....
Total maint. and repairs	0.380	0.300	1.220	0.610	.320	0.300	0.530	.....	0.600	0.367	0.772	0.190	0.227	0.226
Total oper. and maint. (ex. fuel)	1.100	1.100	3.710	1.560	.790	0.700	2.180	.....	1.400	0.784	1.532	0.410	0.925	0.562
Total production (no fixed charges)	2.740	4.000	7.670	4.470	3.950	3.300	3.370	.....	3.670	2.544	4.266	2.670	3.544	2.012
Total gross generation, millions kw.-hr	129.36	81.47	53.00	46.07	181.74	138.27	9.53	.....	178.57	283.82	142.75	366.10	116.97	282.72
Total net generation, millions kw.-hr	123.04	77.94	48.63	43.22	171.00	132.88	3.82	.....	162.45	273.32	136.15	341.82	111.69	270.07
Max. load, kw., 30-min. peak	35,000	18,000	35,000	15,300	40,800	28,400	40,000	.....	45,000	57,000	33,700	54,000	50,000	66,000

[*Continued on page 60*]

[Continued on page 60]

TABLE II—STEAM STATION UNIT INVESTMENT COST, TOTAL POWER COST AND PERFORMANCE (1938)—(Continued)

Station	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Unit Investment Cost, Dollars per kw.:														
Land	.....	.....	.....	.13	.....	1.38	2.97	.....	.....	.....	.27	1.24	8.39	0.72
Buildings and foundations	.....	.....	.....	10.52	.....	23.30	16.50	.....	.....	.....	31.25	20.50	28.10	24.84
Condensing supply works	.....	.....	.....	3.77	.....	.....	2.49	.....	.....	.....	.....	1.90	.....	8.05
Fuel-handling, storage	.....	.....	.....	1.13	.....	.....	1.46	.....	.....	.....	.....	6.15	.....	6.13
Ash handling	.....	.....	.....	.27	.....	.....	.....	.....	.....	.....	.....	0.59	.....	0.30
Boiler plant	.....	.....	.....	10.63	.....	.....	10.37	.....	.....	.....	29.65	17.80	32.58	13.52
Draft system	.....	.....	.....	2.18	.....	.....	1.65	.....	.....	.....	.....	2.49	.....	4.08
Feedwater system	.....	.....	.....	1.10	.....	.....	1.38	.....	.....	.....	.....	2.54	.....	1.66
Piping system	.....	.....	.....	3.25	.....	.....	6.25	.....	.....	.....	.....	6.33	.....	4.40
Turbine foundations	.....	.....	.....	1.75	.....	.....	0.98	.....	.....	.....	.....	.....	.....	0.58
Heat recovery apparatus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.13	.....	.....
Generator air (or H) coolers	.....	.....	.....	.57	.....	.....	0.29	.....	.....	.....	.....	.....	.....	0.79
Turbo-generators	.....	.....	.....	23.70	.....	.....	12.70	.....	.....	.....	27.55	13.10	21.19	12.39
Turbine auxiliaries	.....	.....	.....	.62	.....	.....	1.60	.....	.....	.....	.....	.....	.....	0.34
Main condensers	.....	.....	.....	.....	.....	.....	2.89	.....	.....	.....	.....	2.86	.....	3.23
Switchgear and station wiring	.....	.....	.....	4.85	.....	.....	4.92	.....	.....	.....	6.51	7.44	5.39	8.66
Miscellaneous	.....	.....	.....	.24	.....	52.60	1.10	.....	.....	.....	1.36	21.90	0.87	.....
Total station	.....	.....	.....	64.72	.....	77.28	67.46	.....	.....	.....	96.59	106.00	96.52	89.69
Outdoor switching equipment	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.51	3.98	10.61	5.75
Total station and switchyard	.....	.....	.....	.....	.....	77.28	67.46	.....	153.76	.....	109.10	110.00	107.13	95.44
Cost of Energy (Mills per net kw.-hr.):														
Fixed charges at 15 per cent	.....	.....	.....	8.85	.....	3.65	111.6	.....	7.12	.....	6.60	.....	8.66	3.18
Production charges	3.10	4.00	7.67	4.47	3.95	3.30	3.37	.....	3.67	2.54	4.27	2.67	3.54	2.01
Total cost, actual	.....	.....	.....	13.32	.....	5.95	114.97	.....	10.79	.....	10.87	.....	12.20	5.19
Fixed charges at 90 utilization factor	.....	.....	.....	1.56	.....	2.52	2.21	.....	5.28	.....	3.74	.....	3.68	3.25
Produc. charges at 50 plant factor	.....	.....	.....	3.81	.....	3.28	1.23	.....	3.31	.....	4.00	.....	3.05	1.92
Comparative cost	.....	.....	.....	5.37	.....	5.80	3.44	.....	8.59	.....	7.74	.....	6.73	5.17
Station Performance in 1938:														
Millions B.t.u. used	1,840,000	1,430,000	790,000	870,000	2,680,000	2,063,000	396,800	.....	2,142,000	4,950,000	2,000,000	4,270,000	1,942,000	3,685,000
Fuel cost, cents per million B.t.u.	11.2	15.9	11.8	14.4	13.8	16.2	11.50	.....	17.35	9.82	18.6	18.0	15.10	10.70
B.t.u. per net kw.-hr. send-out	14,214	18,455	14,300	20,110	15,519	15,764	103,700	.....	13,184	19,508	14,733	12,476	17,378	13,625
B.t.u. per gross kw.-hr. generated	13,600	17,630	13,100	18,900	14,600	15,130	41,700	.....	12,000	18,800	14,100	11,600	16,550	13,000
Average boiler efficiency, per cent	83.0	75.5	88.46	81.8	85.87	78	80	.....	82.56	75.3	71.3–87.7	84.2	78.88	83.8
Thermal efficiency, net basis	24	18.5	23.9	17.0	22.0	21.7	3.30	.....	25.9	17.5	23.2	27.4	19.7	25.1
Employees per 1,000 kw. per day	1.60	1.18	1.11	.702	1.37	1.67	.96	.....	1.08	1.26	1.36	.....	0.817	1.05
Plant factor, annual, per cent	47.2	26.1	16.3	14.0	50.0	36.7	2.49	.....	40.8	61.9	29.6	76.0	22.1	53.8
Utilization factor, annual, per cent	112	50.6	94.6	39.8	98.4	66.0	91.5	.....	90	109	61.2	98.3	83.3	110
Station Unit Space Factors:														
Boiler room, cu.ft. per kw	1.26	24.50	59.70	11.40	15.15	8.75	24.50	2.29	16.06	29.50	20.60	.....	6.20	18.25
Turbine room, cu.ft. per kw	4.42	14.12	11.36	12.55	8.24	15.40	15.10	2.31	6.18	12.40	11.18	.....	13.90	12.00
Switchhouse, cu.ft. per kw	0.58	4.65	1.33	.....	.....	.....	1.70	.52	3.08	3.45	4.38	.....	0.20	1.30
Fuel preparation room, cu.ft. per kw	.....	.....	.....	.....	0.20	.....	.....	.....	1.57	.....	.....	.....	5.00	6.58
Station site, sq.ft. per kw	0.22	0.82	1.06	1.27	5.26	0.48	21.35	0.27	4.96	0.72	11.90	.....	0.31	.....
Fuel storage area, sq.ft. per kw	.....	.....	3.30	1.30	.....	0.23 bbl/kw	.....	.....	1.40	1.04	1.03	.....	.....	.....
Switchyard, sq.ft. per kw	0.62	.....	.....	.....	0.13	0.08	1.39	.26	3.08	0.11	0.95	.....	1.02	0.41
Storage capacity, tons per kw	0.42 bbl	.....	0.16	0.03	2.65 bbl/kw	0.17 bbl/kw	.....	0.33 bbl	0.44	0.27	0.36	.....	0.63 bbl	1.67

* Letters in ( ) show listing of stations in Third Steam Station Cost Survey.

Rating groups, kw.: I, to 20,000; II, 20,000 to 40,000; III, 40,000 to 60,000; IV, 60,000 to 75,000; V, 75,000 to 100,000; VI, 100,000 to 150,000; VII, 150,000 to 200,000; VIII, over 200,000.

Normal function: (a) Normal system stations; (b) Normal distribution station; (c) Normal transmission; (d) Normal base load; (e) Standby; (f) Power and district steam.

[1] Some reports gave total number of employees on maintenance, usually working in only one shift. Numbers thus reported are marked T.

[2] Units of 200 cu.ft. and B.t.u. per unit.

[Continued on page 61]

TABLE I—STEAM STATION EQUIPMENT DATA AND PRODUCTION COSTS (1938)—(Continued)

Stations*	29 (M)	30 (T)	31	32 (f)	33	34	35	36	37	38 (I)	39	40 (V)	41	42
Rating group (see footnote)	IV	IV	IV	IV	IV	IV	IV	IV	V	V	V	V	V	V
Normal function (see footnote)	(a)	(a)	(b)	(d)	(a) (d) (e)	.....	.....	(d)	(a)	(d)	(a) (b)	(c)	(a)	(b) (c) (e) (f)
Number of units, condensing	2	3	7	2	3	3	2	2	6	1	5	3	5	8
Superposing or non-condensing	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Boiler units, number	3	5	15	2	6	5	2	5	12	1	6	5	4	24
Size (lb./hour)	345,000	140,000–300,000	15,340–180,000	375,000	90,000–275,000	169,000–303,000	400,000	870,000	30,000–400,000	690,000	125,000–210,000	200,000–320,000	176,760–960,000	25,000–125,000
Steam pressure, boiler, lb	700	400–825	175–400	665	375	400–850	880	418	400	1,390	200–365	400–875	1,325	200–235
Temperature deg. F	775	740–825	480–638	825	750	700–875	900	700	700	835	470–700	700–915	925	515–635
Cooling water, summer, winter, deg. F	78–33	75–35	78–36	83–44	80–50	80–32	.....	81–30	74–60	57.2–37.1	95–79	90–55	85–35	75–49.4
Ave. vacuum (in.)	28.5	1.06	28.81	1.25	1.05–1.14	28.93	.....	28.9	28.5	49	27.83	28.5	2.10	1.20
No. in station shift—oper.-maint.[1]	11–44 T	12–29 T	22–44 T	17–9	8–22 T	42 T–46 T	.....	14–10	16–10	13–10 T	20–54 T	8– (?)	91 T	16–33 T
Plant structure area, acres	1.6	2.2	1.09	0.83	.....	0.75	3.1	33.2 (?)	.....	0.85	1.1	.80	6 (?)	1.9
Fuel storage area, acres	20	7.6	1.0	1.24	.....	4.50	7.3	1.32	.....	7.66	73,400 bbl.	.....	0.1	1.7
Fuels used in plant	Coal-Coke	Coal-Gas	Coal	Coal	Coal	Coal	Coal	Coal-Oil	Oil-Hog	Coal	Oil-Gas	Gas	Coal	Coal
Station Details:														
Stokers	.....	.....	√	.....	.....	.....	.....	.....	.....	.....	.....	.....	√	√
Pulverized fuel	√	√	√	√	√	.....	√	√	.....	√	.....	.....	√	.....
Oil	.....	.....	.....	.....	.....	.....	.....	√	√	.....	.....	√	.....	.....
Gas	.....	√	.....	.....	.....	.....	.....	.....	.....	.....	√	√	.....	.....
Air preheating	√	√	√	√	√	.....	√	√	√	√	√	√	√	.....
Steam reheating	.....	.....	.....	.....	.....	.....	.....	.....	.....	√	.....	.....	.....	.....
Economizers	√	√	√	√	√	.....	√	√	√	.....	.....	√	√	.....
Waterwall furnaces	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Stage bleeding	√	√	√	√	√	.....	√	√	√	√	√	√	√	√
Duplicate feed pumps	√	√	√	√	√	.....	√	√	√	√	√	√	√	√
Duplicate circulating pumps	√	√	√	.....	√	.....	.....	√	√	√	√	√	√	.....
Generator air coolers	√	√	√	√	√	.....	.....	√	√	√	√	√	√	√
Generator hydrogen cooler	.....	.....	.....	.....	.....	.....	√	.....	.....	.....	.....	.....	√	.....
Automatic combustion system	.....	√	√	√	√	.....	√	.....	√	√	.....	√	√	.....
Water cooling tower	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Outdoor switchyard	√	√	√	.....	√	.....	√	√	.....	√	√	√	√	√
Fuel Data for 1938:														
Total fuel used:														
Short tons of coal	207,673	33,875	133,784	199,774	250,567	209,850	.....	49,108	72,559[2]	162,724	.....	.....	225,234	84,400
Barrels of oil	.....	.....	.....	.....	.....	.....	.....	705,343	207,447	.....	1,289	.....	.....	.....
M cu.ft. of gas	.....	1,788,545	.....	.....	.....	.....	.....	.....	.....	.....	3,391,272	3,783,732	.....	.....
Heat value as fired, B.t.u.:														
Coal per lb.	11,337	10,104	11,870	14,393	9,217	9,995	.....	14,262	16,000,000[2]	13,051	.....	.....	13,219	11,170
Oil per gallon	.....	.....	.....	.....	.....	.....	.....	152,800	150,000	.....	145,400	.....	.....	.....
Gas per cu.ft.	.....	1,045	.....	.....	.....	.....	.....	.....	.....	.....	1,047	1,073	.....	.....
Cost Delivered, Dollars:														
Coal per ton	3.50	2.14	2.60	4.37	2.39	1.86	.....	4.36	.....	4.24	.....	.....	1.56	2.71
Oil per barrel	.....	.....	.....	.....	.....	.....	.....	.92	.....	.....	0.95	.....	.....	.....
Gas per M cu.ft.	.....	12.1	.....	.....	.....	.....	.....	.....	.....	.....	0.13	0.097	.....	.....
Ash content, per cent	9.57	12.49	15.73	5.97	.....	17.49	.....	6.2	.....	9.29	.....	.....	8.7	12
Moisture, per cent	12.85	15.09	6.607	2.25	.....	15.46	.....	3.	.....	4.4	.....	.....	3.4	10.21
Operating Costs (Mills per net kw.-hr.):														
Fuel	2.335	1.840	2.350	1.874	2.150	1.610	.....	2.187	3.340	1.751	1.990	1.420	0.973	2.100
Wages and superintendence	0.244	0.510	1.860	0.251	0.319	0.370	.....	0.277	0.890	0.302	0.530	0.310	0.366	1.800
Water, lubrication and supplies	0.037	0.060	0.340	0.030	0.056	0.040	.....	0.053	0.055	0.023	0.120	0.070	0.035	0.200
Maintenance and repairs:														
Buildings and structures	0.026	0.070	0.040	0.008	0.011	0.030	.....	0.038	0.078	0.011	0.060	0.060	.....	0.060
Boiler plant	0.103	0.130	0.420	0.043	0.092	0.135	.....	0.115	0.319	0.070	0.190	0.110	.....	0.160
Fuel handling	0.059	0.060	0.040	0.059	0.046	0.115	.....	0.049	0.232	.....	.....	.....	.....	0.100
Prime movers and auxiliaries	0.009	0.060	0.080	0.015	0.026	.....	.....	0.046	0.085	0.034	0.100	0.070	.....	0.080
Electrical equip. and misc	0.017	0.050	0.140	0.012	0.050	.....	.....	0.039	0.071	0.030	0.120	0.020	.....	0.040
Supervision and engineering	0.043	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total maint. and repairs	0.258	0.370	0.720	0.137	0.225	0.280	.....	0.287	0.816	0.145	0.470	0.260	0.186	0.440
Total oper. and maint. (ex. fuel)	0.540	0.940	2.920	0.418	0.601	0.690	.....	0.617	1.760	0.470	1.120	0.640	0.587	2.440
Total production (no fixed charges)	2.876	2.780	5.270	2.292	2.751	2.300	.....	2.804	5.100	2.221	3.110	2.060	1.560	4.540
Total gross generation, millions kw.-hr	375.91	167.33	159.45	489.68	296.62	260.57	.....	416.25	129.92	415.72	225.09	274.15	399.23	65.78
Total net generation, millions kw.-hr	354.02	157.47	147.81	466.46	282.64	243.32	.....	39.657	115.77	393.71	210.52	257.70	375.26	58.39
Max. load, kw., 30-min. peak	65,000	43,700	30,500	71,000	70,900	44,000	.....	77,650	48,000	80,000	69,300	61,600	94,200	66,000

[*Continued on page 62*]

[Continued on page 62]

TABLE II—STEAM STATION UNIT INVESTMENT COST, TOTAL POWER COST AND PERFORMANCE (1938)—(Continued)

Station	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Unit Investment Cost, Dollars per kw.:														
Land	15.70	0.91	.481	5.44	.....	.....	4.49	.....	.....	5.24	.....	1.04	.....	.....
Buildings and foundations	45.60	14.88	14.88	15.86	.....	.....	12.40	.....	.....	21.29	.....	23.40	.....	.....
Condensing supply works	6.87	1.08	10.95	.....	.....	.....	3.69	.....	.....	1.83	.....	.....	.....	.....
Fuel-handling, storage	8.00	3.79	.....	2.95	.....	.....	2.91	.....	.....	19.03	.....	.....	.....	.....
Ash handling	0.44	1.03	.....	0.83	.....	.....	.....	.....	.....	0.75	.....	.....	.....	.....
Boiler plant	20.35	12.55	27.45	9.54	.....	.....	7.19	.....	.....	13.24	.....	32.20	.....	.....
Draft system	1.10	1.98	.....	5.00	.....	.....	2.04	.....	.....	1.48	.....	.....	.....	.....
Feedwater system	1.56	1.36	.....	1.90	.....	.....	.42	.....	.....	3.01	.....	.....	.....	.....
Piping system	10.17	4.62	1.67	5.37	.....	.....	4.47	.....	.....	3.02	.....	.....	.....	.....
Turbine foundations	0.60	0.84	.....	.....	.....	.....	.62	.....	.....	0.93	.....	.....	.....	.....
Heat recovery apparatus	4.93	1.74	.....	.....	.....	.....	.75	.....	.....	1.79	.....	.....	.....	.....
Generator air (or H) coolers	.....	0.43	.....	0.30	.....	.....	.....	.....	.....	0.24	.....	.....	.....	.....
Turbo-generators	17.94	17.45	23.10	17.79	.....	.....	18.62	.....	.....	17.01	.....	27.70	.....	.....
Turbine auxiliaries	1.44	4.03	.....	2.42	.....	.....	3.61	.....	.....	3.22	.....	10.10	.....	.....
Main condensers	.....	.....	.....	2.59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Switchgear and station wiring	14.90	8.52	14.25	15.52	.....	.....	6.17	.....	.....	8.05	.....	.....	.....	.....
Miscellaneous	2.66	9.22	2.11	1.24	.....	.....	12.42	.....	.....	.....	.....	0.16	.....	.....
Total station	152.26	84.43	94.89	86.76	.....	96.50	79.74	.....	.....	100.13	.....	94.60	.....	.....
Outdoor switching equipment	1.66	2.61	.....	4.11	.....	.....	13.12	.....	.....	5.69	.....	8.75	.....	.....
Total station and switchyard	153.92	87.04	.....	90.87	107.8	96.50	92.86	179.20	.....	105.82	.....	103.35	.....	.....
Cost of Energy (Mills per net kw.-hr.):														
Fixed charges at 15 per cent	4.17	5.67	6.66	2.05	4.00	4.25	.....	5.10	.....	3.32	.....	5.12	.....	.....
Production charges	2.88	2.78	5.27	2.92	2.75	2.30	.....	2.80	5.10	2.22	3.11	2.06	1.56	4.54
Total cost, actual	7.05	8.45	11.93	4.34	6.75	6.55	.....	7.90	.....	5.54	.....	7.18	.....	.....
Fixed charges at 90 utilization factor	5.33	2.70	3.21	3.12	4.05	3.31	.....	5.95	.....	3.84	.....	3.49	.....	.....
Produc. charges at 50 plant factor	2.94	2.54	5.25	2.44	2.69	2.39	.....	2.84	.....	2.23	.....	1.96	.....	.....
Comparative cost	8.27	5.24	8.46	5.56	6.74	5.60	.....	8.79	.....	6.07	.....	5.45	.....	.....
Station Performance in 1938:														
Millions B.t.u. used	4,700,000	2,555,000	3,180,000	5,750,000	4,600,000	4,180,000	.....	5,920,000	1,160,000	4,250,000	3,557,000	4,070,000	5,960,000	1,880,000
Fuel cost, cents per million B.t.u.	15.45	11.31	9.68	15.20	13.0	9.34	.....	14.50	.....	16.24	11.8	9.02	5.9	12.1
B.t.u. per net kw.-hr. send-out	13,302	16,128	21,307	12,329	16,342	17,243	.....	14,954	21,300	10,788	16,899	15,769	15,938	31,820
B.t.u. per gross kw.-hr. generated	12,580	15,200	19,700	11,750	15,600	16,100	.....	14,250	18,950	10,200	16,150	14,300	15,000	28,200
Average boiler efficiency, per cent	86.93	80.4–84.8	60.0–84.4	84.16	82.53	84.0	.....	86.3	.....	86.65	81.3	80	.....	71.5
Thermal efficiency, net basis	25.70	21.2	16.0	27.7	20.9	19.9	.....	22.9	16.1	31.7	20.2	21.7	21.5	10.75
Employees per 1,000 kw. per day	1.20	.95	1.60	1.11	0.657	1.23	.....	.96	1.006	0.61	1.38	0.283	1.01	0.876
Plant factor, annual, per cent	67.2	28.0	26.4	81.5	48.5	41.7	.....	63.4	19.2	59.3	31.1	36.8	50.5	8.12
Utilization factor, annual, per cent	102.5	64.2	43.5	101.4	101.3	61.7	.....	103.5	62	100	84.0	72.5	104	71.3
Station Unit Space Factors:														
Boiler room, cu.ft. per kw	31.20	23.60	18.70	22.00	15.47	23.00	15.86	26.90	.....	15.50	16.85	11.05	18.30	16.72
Turbine room, cu.ft. per kw	27.00	21.30	36.70	13.83	15.77	26.15	9.46	16.50	.....	8.97	6.65	9.62	7.22	7.62
Switchhouse, cu.ft. per kw	0.31	3.58	3.49	7.81	4.83	.....	.....	2.64	.....	6.55	0.41	0.44	0.49	9.41
Fuel preparation room, cu.ft. per kw	.....	.....	.....	.....	2.58	.....	.....	6.95	.....	.....	.....	.....	0.15	3.45
Station site, sq.ft. per kw	1.09	1.40	0.69	0.52	.....	0.46	1.94	19.25 (?)	.....	0.46	0.57	.....	2.88	0.89
Fuel storage area, sq.ft. per kw	13.62	4.85	0.63	0.77	.....	2.75	4.54	0.77	.....	4.18	.....	.....	0.05	0.79
Switchyard, sq.ft. per kw	1.78	.....	0.03	.....	0.89	.....	1.76	1.30	.....	0.52	0.25	0.58	0.93	.05
Storage capacity, tons per kw	0.29	0.03	0.15	0.29	0.29	0.84	2.36	0.73	.....	.....	0.87 bbl	.....	0.01	0.01

* Letters in ( ) show listing of stations in Third Steam Station Cost Survey.

Rating groups, kw.: I, to 20,000; II, 20,000 to 40,000; III, 40,000 to 60,000; IV, 60,000 to 75,000; V, 75,000 to 100,000; VI, 100,000 to 150,000; VII, 150,000 to 200,000; VIII, over 200,000.

Normal function: (a) Normal system stations; (b) Normal distribution station; (c) Normal transmission; (d) Normal base load; (e) Standby; (f) Power and district steam.

[1] Some reports gave total number of employees on maintenance, usually working in only one shift. Numbers thus reported are marked T.

[2] Units of 200 cu.ft. and B.t.u. per unit.

[Continued on page 63]

TABLE I—STEAM STATION EQUIPMENT DATA AND PRODUCTION COSTS (1938)—(Concluded)

Stations*	43	44	45	46 (P)	47	48 (U)	49	50	51	52	53 (C)	54	55 (Q)	56
Rating group (see footnote)	V	VI	VI	VI	VI	VI	VI	VII	VII	VIII	VIII	VIII	VIII	III
Normal function (see footnote)	(a)	(a) (e) (f)	(a)	(a)	(a) (d)	(a)	(a)	(a)	(a) (b)	(d)	(a)	(a)	(d)	(a)
Number of units, condensing	5	7	4	2	2	4	6	5	3	5	4	6	3	2
Superposing or non-condensing	0	2	1	3	0	1	1	2	0	1	0	1	0	0
Boiler units, number	9	15	13	6	5	6	8	11	4	11	8	18	14	6
Size (lb./hour)	100,000–200,000	52,000–240,000	120,000–300,000	290,000–330,000	350,000	450,000 Max.	150,000–375,000	125,000–350,000	287,500	150,000–450,000	325,000–330,000	605,000–150,000	230,000–600,000	9,000 hp.
Steam pressure, boiler, lb	240	650–220	250–900	1,350	415	900 Max.	240–1,320	1,250	405	350–1,250	825–393	225–1,350	400	385
Temperature deg. F	700	750–520	550–825	725	750	915 Max.	575–900	820	725	680–935	866–700	600–950	850	700
Cooling water, summer, winter, deg. F	74–59	75–33	78–40	80–38	76.2–34.5	80–34	79–36	83–34	77–35	74–38	72–35	81–39	80–40	82–34
Ave. vacuum (in.)	28 7	28.10	28.85	1.16	28	28.85	27.99	1.1	29	28.78	0.80	28.77	1.23	23.3
No. in station shift—oper.-maint.[1]	28 T–38 T	19–18 T	9–48 T	190 T	110 T–33 T	11–(?)	23–97 T	33–52 T	.....	107 T–125 T	189 T–91 T	242 T–154 T	39–25 tot.	63 T
Plant structure area, acres	1.02	2.8	2.05	70 (?)	1.9	1.50	1.1	1.6	2.5	1.9	2.50	2.6	3.6	.75
Fuel storage area, acres	0.17	.....	8	30	11.1	6	3	5	1	14.0	14	7	10	2.095
Fuels used in plant	Oil-Gas	Coal	Coal-Gas	Coal	Coal	Coal-Oil	Coal	Coal-Oil-Gas	Coal	Coal	Coal-Gas	Coal-Oil	Coal	Coal
Station Details:														
Stokers	.....	√	√	.....	√	√	√	√	.....	√	√	√	√	√
Pulverized fuel	.....	√	√	√	.....	√	√	√	√	√	.....	√	√	.....
Oil	√	.....	.....	.....	.....	√	.....	√	.....	.....	.....	√	.....	.....
Gas	√	.....	√	.....	.....	.....	.....	√	.....	.....	√	.....	.....	.....
Air preheating	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Steam reheating	.....	.....	.....	√	.....	.....	.....	√	.....	.....	.....	.....	.....	.....
Economizers	.....	√	√	√	√	√	√	√	.....	√	√	√	√	√
Waterwall furnaces	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Stage bleeding	√	.....	√	√	√	√	√	√	√	√	√	√	√	√
Duplicate feed pumps	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Duplicate circulating pumps	.....	√	.....	.....	.....	√	.....	√	√	√	√	√	√	√
Generator air coolers	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Generator hydrogen cooler	.....	√	.....	.....	√	.....	√	.....	.....	√	.....	√	.....	.....
Automatic combustion system	√	√	√	√	√	√	√	√	√	√	.....	√	√	.....
Water cooling tower	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Outdoor switchyard	.....	.....	√	√	√	.....	√	√	√	√	.....	√	√	√
Fuel Data for 1938:														
Total fuel used:														
Short tons of coal	.....	74,475	239,945	488,822	212,795	33,268	235,076	166,313	126,805	681,794	218,866	251,669	708,782	217,907
Barrels of oil	19,640	.....	.....	.....	.....	603,408	.....	422	.....	.....	.....	1,059,763	.....	.....
M cu.ft. of gas	3,049,952	.....	51,880	.....	.....	.....	.....	3,406,527	.....	.....	12,466,056	.....	.....	.....
Heat value as fired, B.t.u.:														
Coal per lb	.....	13,555	13,198	14,069	12,836	14,310	13,629	10,513	14,100	12,920	13,490	14,148	14,038	9,249
Oil per gallon	146,119	.....	.....	.....	.....	154,000	.....	151,659	.....	.....	.....	153,502	.....	.....
Gas per cu.ft	1,136	.....	595.7	.....	.....	.....	.....	1,023	.....	.....	93.5	.....	.....	.....
Cost Delivered Dollars:														
Coal per ton	.....	4.15	3.69	4.27	2.58	5.71	3.62	2.44	5.66	2.40	3.79	4.55	4.55	2.49
Oil per barrel	1.108	.....	.....	.....	.....	1.16	.....	1.06	.....	.....	.....	1.05	.....	.....
Gas per M cu.ft	0.16	.....	0.08	.....	.....	.....	.....	.11	.....	.....	1.17	.....	.....	.....
Ash content, per cent	.....	8.3	8.5	6.1	11.5	3.5	6.40	16.45	6.4	12.2	7.3	6.09	6.60	15.28
Moisture, per cent	.....	4.6	5.6	4.2	3.8	3.0	3.97	11.11	3	3.1	4.28	4.15	3.15	16.56
Operating Costs (Mills per net kw.-hr.):														
Fuel	2.290	3.750	2.729	1.864	1.482	2.690	2.260	1.680	2.722	1.580	1.926	2.430	2.140	2.259
Wages and superintendence	0.470	1.352	0.449	0.227	0.274	0.576	0.510	0.590	0.649	0.369	1.021	0.566	0.193	0.316
Water, lubrication and supplies	0.060	0.438	0.047	0.024	0.094	0.056	0.130	0.060	0.065	0.049	0.105	0.079	0.020	0.049
Maintenance and repairs:														
Buildings and structures	0.070	0.143	0.058	.....	0.013	0.082	0.030	0.020	0.060	0.013	0.090	0.070	0.040	0.013
Boiler plant	0.180	0.547	0.298	.....	0.051	0.155	0.150	0.193	0.194	0.093	0.021	0.124	0.100	0.130
Fuel handling	.....	0.182	0.058	.....	0.031	0.010	0.050	0.040	0.079	0.028	0.053	0.039	0.010	0.019
Prime movers and auxiliaries	0.130	0.258	0.097	.....	0.023	0.055	0.260	0.090	0.210	0.048	0.036	0.135	0.020	0.099
Electrical equip. and misc	0.040	0.083	0.009	.....	0.038	0.082	0.030	0.010	0.193	0.032	0.122	0.134	0.030	0.026
Supervision and engineering	0.040	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.022
Total maint. and repairs	0.046	1.213	0.520	0.202	0.156	0.384	0.520	0.390	0.736	0.213	0.512	0.502	0.200	0.311
Total oper. and maint. (ex. fuel)	0.990	3.003	1.016	0.453	0.524	1.048	1.160	1.040	1.450	0.633	1.637	1.147	0.410	0.676
Total production (no fixed charges)	3.280	6.756	3.745	2.317	2.006	3.738	3.420	2.720	4.172	2.213	3.563	3.577	2.550	2.935
Total gross generation, millions kw.-hr	229.74	88.20 (6 mo.)	343.66	937.70	390.53	348.78	448.01	495.15	258.19	1,111.72	524.85	986.77	1,600.33	252.03
Total net generation, millions kw.-hr	218.69	82.85 (6 mo.)	325.82	863.25	381.56	331.62	426.82	466.76	239.45	1,035.09	503.24	946.61	1,524.25	240.22
Max. load, kw., 30-min. peak	63,600	74,200	122,000	134,000	132,700	109,000	103,000	114,000	73,000	196,303	200,000	225,000	262,000	53,000

TABLE II—STEAM STATION UNIT INVESTMENT COST, TOTAL POWER COST AND PERFORMANCE (1938)—(Concluded)

Station	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Unit Investment Cost, Dollars per kw.:											Excludes investment in unfinished equipment			
Land	2.42	1.29	.....	.....	1.73	0.52	0.42	.....	1.17	2.24	5.67	3.05	2.08	.....
Buildings and foundations	12.59	20.32	.....	.....	22.35	35.00	20.98	.....	20.50	31.10	27.05	21.60	33.48	.....
Condensing supply works	10.83	.....	.....	.....	7.04	.....	.....	.....	1.19	.....	3.38	.....	3.55	.....
Fuel-handling, storage	.55	.....	.....	.....	6.97	.....	3.47	.....	3.91	.....	7.34	.....	1.39	.....
Ash handling	.....	.....	.....	.....	1.22	.....	.....	.....	.76	.....	0.19	.....	0.63	.....
Boiler plant	19.40	32.60	.....	.....	12.52	40.95	.....	.....	7.84	37.55	6.80	30.70	11.54	.....
Draft system	.....	.....	.....	.....	3.31	.....	20.35	.....	1.64	.....	1.87	.....	3.64	.....
Feedwater system	.....	.....	.....	.....	1.68	.....	.....	.....	2.41	.....	0.86	.....	3.13	.....
Piping system	6.13	.....	.....	.....	3.53	.....	3.46	.....	3.57	.....	4.45	.....	7.67	.....
Turbine foundations	.....	.....	.....	.....	.....	.....	.....	.....	.92	.....	0.60	.....	.....	.....
Heat recovery apparatus	.....	.....	.....	.....	.....	.....	.....	.....	1.43	.....	1.38	.....	.....	.....
Generator air (or H) coolers	.....	.....	.....	.....	.....	.....	.....	.....	.05	.....	0.17	.....	0.52	.....
Turbo-generators	25.30	22.45	.....	.....	14.24	23.86	21.70	.....	16.99	23.70	9.10	33.30	25.20	.....
Turbine auxiliaries	.47	.....	.....	.....	.....	.....	.....	.....	.01	10.58	4.98	.....	0.99	.....
Main condensers	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.95	.....
Switchgear and station wiring	9.57	7.93	.....	.....	12.87	11.34	9.45	.....	.01	.....	1.41	.....	12.95	.....
Miscellaneous	0.37	0.22	.....	.....	30.80	2.10	0.80	.....	9.17	2.31	6.70	0.82	1.94	.....
Total station	87.73	84.81	.....	.....	118.20	113.77	81.29	.....	71.65	104.48	82.00	89.47	98.40	.....
Outdoor switching equipment	.....	.....	.....	.....	.....	0	0	.....	4.45	7.10	.....	10.55	2.53	.....
Total station and switchyard	.....	.....	.....	.....	118.20	113.77	81.29	109.60	76.10	111.58	.....	100.02	100.93	.....
Cost of Energy (Mills per net kw.-hr.):														
Fixed charges at 15 per cent	5.94	15.80	.....	.....	5.58	.....	4.02	5.48	8.12	3.41	5.50	3.86	2.83	.....
Production charges	3.28	6.76	3.75	2.32	2.01	3.74	3.42	2.72	4.17	2.21	3.56	3.58	2.55	2.94
Total cost, actual	9.22	22.56	.....	.....	7.59	.....	7.44	8.20	12.29	5.62	9.06	7.44	5.38	.....
Fixed charges at 90 utilization factor	3.00	2.94	.....	.....	4.07	6.23	2.29	3.77	2.88	3.84	2.53	3.42	3.46	.....
Produc. charges at 50 plant factor	2.89	6.03	.....	.....	1.73	.....	3.24	2.55	3.80	2.26	5.29	3.42	2.63	.....
Comparative cost	5.80	8.97	.....	.....	5.80	.....	6.03	6.32	6.68	6.10	7.82	6.84	6.09	.....
Station Performance in 1938:														
Millions B.t.u. used	3,580,000	2,020,000	6,330,000	13,750,000	5,450,000	4,862,000	6,300,000	6,980,000	3,550,000	17,600,000	7,065,000	13,770,000	19,800,000	4,030,000
Fuel cost, cents per million B.t.u.	14.0	15.3	14.3	15.15	10.08	18.51	13.5	10.7	20.2	9.26	13.80	8.87	16.30	13.5
B.t.u. per net kw.-hr. send-out	16,417	15,707	19,534	12,001	14,255	14,857	15,013	14,964	14,932	17,016	14,030	14,592	13,055	16,780
B.t.u. per gross kw.-hr. generated	15,650	14,750	18,500	11,100	13,900	14,100	14,300	11,600	13,850	15,850	13,500	14,000	12,450	15,400
Average boiler efficiency, per cent.	81.44	80.3	76.5	87.74	83	78.0	80.94	80.9	.....	82.4	83.4	81	84.2	79.6
Thermal efficiency, net basis	20.8	20.8	17.5	28.5	24.1	23.0	22.8	22.9	22.9	20.1	24.4	23.4	26.2	22.0
Employees per 1,000 kw. per day	0.67	0.734	0.652	1.60	1.19	.....	1.18	.977	.....	1.11	1.24	1.63	.502	1.26
Plant factor, annual, per cent	26.5	9.85	34.5	90.2	37.2	30.6	36.6	36.4	17.3	60.8	26.6	46.3	64.0	57.6
Utilization factor, annual, per cent.	64.3	72.8	106.2	113	111	83.7	73.6	73.3	42.8	93.5	89	92.6	92	106
Station Unit Space Factors:														
Boiler room, cu.ft. per kw	11.83	19.92	32.60	31.10	13.90	16.15	21.22	26.10	14.54	21.60	24.45	22.25	27.40	38.80
Turbine room, cu.ft. per kw	18.61	9.50	20.85	21.90	6.27	10.20	11.63	4.87	9.77	7.26	23.10	10.60	23.35	14.85
Switchhouse, cu.ft. per kw	2.50	3.70	6.09	0.58	7.00	4.22	4.26	5.24	2.05	3.20	7.32	4.82	9.52	7.54
Fuel preparation room, cu.ft. per kw	.....	.....	.....	0.06	0.33	.....	.....	.....	2.68	2.06	2.41	.....	1.13	11.30
Station site, sq.ft. per kw	0.45	1.19	0.78	25.70	0.69	0.50	0.34	0.45	0.64	0.39	0.49	0.47	0.55	0.65
Fuel storage area, sq.ft. per kw	0.12 bbl	.....	3.03	11.00	4.02	2.01	0.94	1.41	0.26	2.80	2.71	1.26	1.53	1.83
Switchyard, sq.ft. per kw	.....	.....	0.24	1.66	0.24	.....	0.43	1.58	0.17	0 18	.....	0 97	0.21	0.60
Storage capacity, tons per kw	.....	0.05	0.52	0.76	1.45	2.92	0.37	0.45	0.12	0.48	0.59	0.25	0.21	1.00

* Letters in ( ) show listing of stations in Third Steam Station Cost Survey.

Rating groups, kw.: I, to 20,000; II, 20,000 to 40,000; III, 40,000 to 60,000; IV, 60,000 to 75,000; V, 75,000 to 100,000; VI, 100,000 to 150,000; VII, 150,000 to 200,000; VIII, over 200,000.

Normal function: (a) Normal system stations; (b) Normal distribution station; (c) Normal transmission; (d) Normal base load; (e) Standby; (f) Power and district steam.

[1] Some reports gave total number of employees on maintenance, usually working in only one shift. Numbers thus reported are marked T.

[2] Units of 200 cu.ft. and B.t.u. per unit.

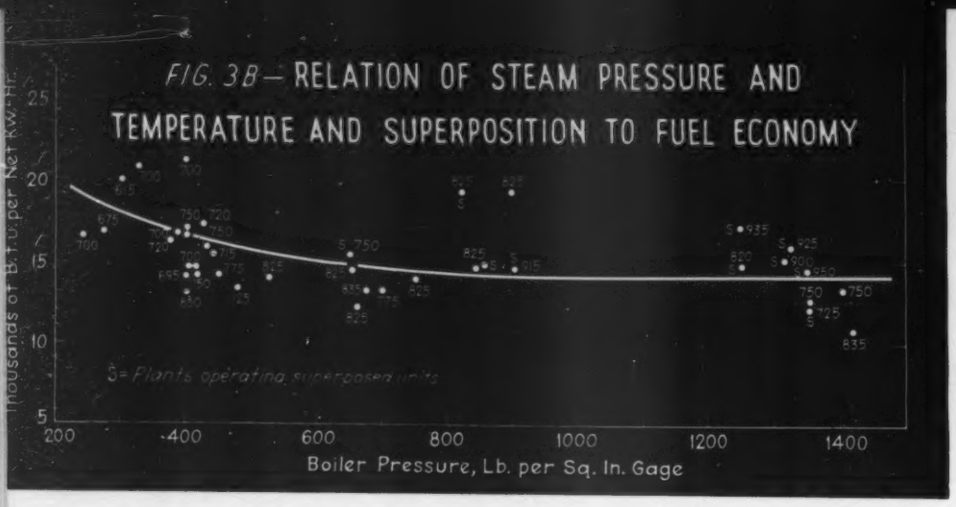


FIG. 38—RELATION OF STEAM PRESSURE AND TEMPERATURE AND SUPERPOSITION TO FUEL ECONOMY

will come as the stations are more completely superposed and loaded to derive maximum benefit from the assembly. Strangely, some high-pressure plants with the higher values of superheat seem not to give as good thermal performance as lower pressure plants with lower total steam temperature. Regardless of operating pressure, temperature and superposition, the larger plants show a 10 per cent smaller consumption of heat units per kilowatt-hour than do the smallest ones (Fig. 3-C).

Wide range is noted in the amount of space provided for fuel storage (see Tables I and II). As high as three-fifths of a year's supply is reported, but the general average for coal storage is 0.63 ton per kilowatt, and this means roughly a two months' supply. For oil, the average storage capacity for ten stations is 0.67 barrel per kilowatt, a matter of two weeks' supply.

Station auxiliaries and losses consume from 10 to 16 per cent of the fuel energy represented by generated output, the lower value applying to the larger plants.

Station Auxiliaries

Water walls predominate — Turbine bleeding common — Air preheating usual practice — Automatic combustion adopted for three-fifths of plants — Many use multiple fuels

TRENDS of design over the past decade are confirmed by the accompanying table. All but two of the 56 stations have furnaces with water walls; all but one has feed pumps in duplicate, and all but four engage in some degree of bleeding at the turbine. Air for combustion is preheated at 47 of the 56 plants. Pulverized fuel is used in 32 and stokers are reported for 20 stations. Almost as many (seven) use coal and oil as use oil and gas (eight). Steam reheating is the practice in only four plants. Three in five plants use economizers and about the same fraction have automatic combustion systems, more common in the larger plants. Growing insufficiency of condensing water is reflected in the water cooling towers reported for three of the smaller plants.

Fuel and Equipment Characteristics of Stations

Group	I	II	III	IV	V	VI	VII	VIII	Total
Kw. Range	0 to 20,000	20,000 to 40,000	40,000 to 60,000	60,000 to 75,000	75,000 to 100,000	100,000 to 150,000	150,000 to 200,000	Over 200,000	
No. of Plants	6	12	11	8	7	6	2	4	56
Stokers	1	3	3	1	2	5	1	4	20
Pulverized fuel	3	5	5	7	2	5	2	3	32
Oil	0	1	1	0	1	0	0	0	3
Gas	2	1	2	0	1	0	0	0	6
Coal and oil	0	2	2	1	0	1	0	1	7
Coal and gas	0	0	0	1	0	1	0	1	3
Oil and gas	0	4	2	0	2	0	0	0	8
Coal, oil and gas	0	0	0	0	0	0	1	0	1
Air preheating	4	7	11	7	6	6	2	4	47
Steam preheating	0	0	1	0	1	1	1	0	4
Economizers	1	8	5	7	2	6	1	4	34
Water wall furnaces	5	11	11	8	7	6	2	4	54
Stage bleeding	6	11	10	7	7	5	2	4	52
Duplicate feed pumps	6	12	11	7	7	6	2	4	55
Duplicate circulating pumps	0	9	9	5	5	2	2	4	36
Generator air coolers	5	12	11	6	7	6	2	4	53
Generator hydrogen coolers	0	0	0	1	1	3	0	2	7
Automatic combustion system	0	4	6	5	5	6	2	3	31
Water cooling tower	0	2	1	0	0	0	0	0	3

Comparative Factors of Station Design

Steam-end maintenance reduced by bettered plant factor — Maintenance staffs small in small, well-loaded plants — Crowding capacity adds to maintenance costs

REGARDLESS of all the variations in design and in schedule of operations, the production cost of energy is about the same, 3 mills per kilowatt-hour, for the smallest as it is for the largest stations. However, the effect of plant size shows up in the dilution of fixed charges on investment for larger structures and units. The over-all result is to make energy at the bus cost about 2 mills less per kilowatt-hour at the largest than at the smallest stations.

However, there are wide variations among plants within the same size group as to both production costs and fixed charges. These differences, of course, are readily attributable to differences in plant factor and utilization factor as well as to cost of fuel, etc.

In order to eliminate the principal variables, the performance of 32 (all those for which investment data were furnished) was computed on a common basis of plant factor and utilization factor. From the tables it appears that 50 per cent is a representative value for plant factor and 90 per cent for utilization factor. All the plants for which investment data were reported were converted to this basis of operation by the following simple procedure:

Assume 100,000-kw. plant which operated at 80 per cent utilization factor (peak 80,000 kw.) and 40 per cent plant factor.

Fixed Charges

1. To have operated at 90 per cent utilization factor the plant would have had to be reduced to 89,000 kw. capacity.
2. Consequently the new fixed charges would be reduced to a value $F = 8/9 \times$ the actual fixed charges on 100,000 kw.
3. To operate at 50 per cent plant factor the output would be $89{,}000 \times 8{,}760 \times 0.50 = 390{,}000{,}000$ kw.-hr. instead of the actual $100{,}000 \times 8{,}760 \times 0.40 = 350{,}000{,}000$ kw.-hrs.
4. The fixed charges per kw.-hr. become $F/390{,}000{,}000$.

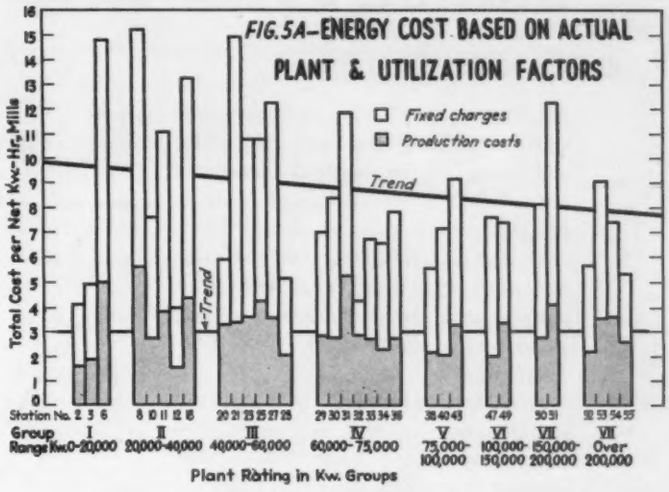
Operating Cost

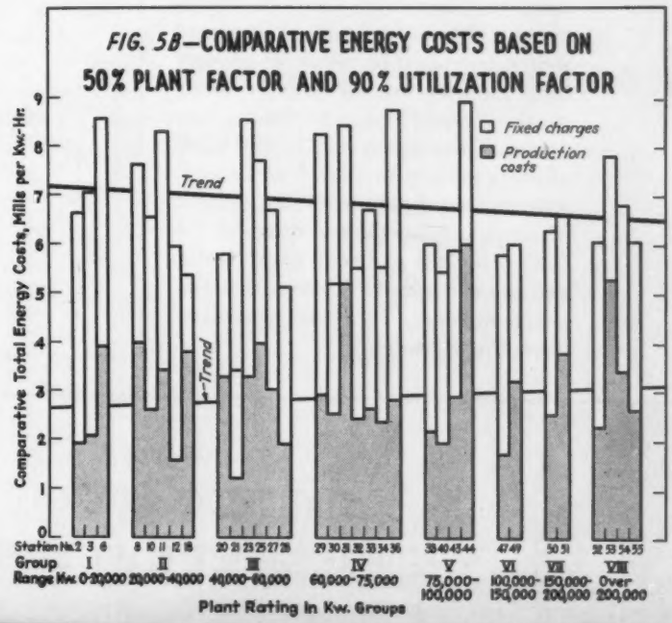
1. Assume fuel cost per kw.-hr. remains unchanged.
2. Distribute other operating expenses among 390,000,000 kw.-hr. (instead of 350,000,000).
3. Add the fuel costs and new "other operating" expenses to obtain operating cost of 89,000-kw. station at 50 per cent plant factor.

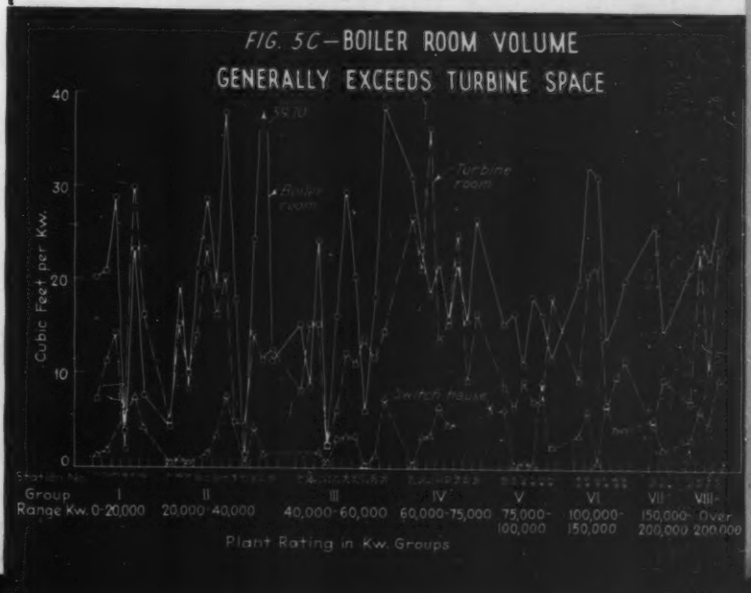
Data determined in this way are plotted in Fig. 5-B.

Placing the stations on this comparable basis reveals several significant points:

1. American power plants are being designed on the average so that they can, with comparable loading, develop energy at a total cost which shows relatively slight advantage for large plants.
2. The saving in fixed charge at large plants is nearly offset by increased production costs.
3. The superior advantage of large plants under actual conditions of operation as to total energy cost is largely attributable to their base load operation.
4. A harmony of design is revealed which is not disclosed by analysis of performance under the relatively disadvantageous condition of actual operation. As plant and utilization factors gravitate toward more advantageous figures, the







industry will benefit by this common objective of prevailing designs.

Despite the general unity of design measured in terms of energy cost, the stations reflect a wide variation in space devoted to boiler room, turbine room and switch house. As shown in Fig. 5-C, the cubic feet devoted to turbines may be several times that devoted to steam generation, and *vice versa*. Undoubtedly some of this wide variation is attributable to the age of certain plants, the steam pressures and fuels used, but nevertheless there is much food for thought here on optimum use of ground and structural space which may cost up to one-third the total station investment.

Station Maintenance

Notable unity is presented by varied designs when performance is converted to a comparable basis for analysis — Space factor varies widely for plants of assorted vintage

AS PLANT FACTOR improves, the station maintenance cost per kilowatt-hour of net output decreases (Fig. 4-A). However, this decrease is less rapid after passing about 65 per cent plant factor. It is for the relatively infrequently used stations that maintenance expense becomes a more important component of total production costs.

Also, for the lower plant factors the maintenance costs of the boiler and everything behind it devoted to combustion and steam generation constitute well over half the total maintenance for all facilities, electric and steam. For plant factor of 50 per cent (full capacity use for half the hours of the year), however, the maintenance of the steam end of the plant appears to drop to a third of the total maintenance outlay per kilowatt-hour of output. Also, the crowding of the station to 100 per cent plant factor and above tends to increase maintenance of steam facilities as a component of the total.

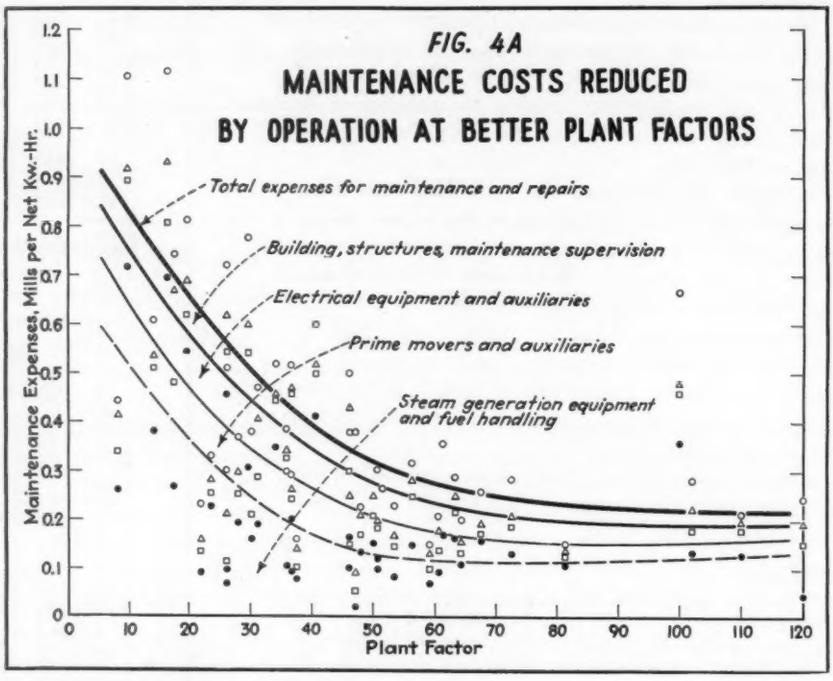
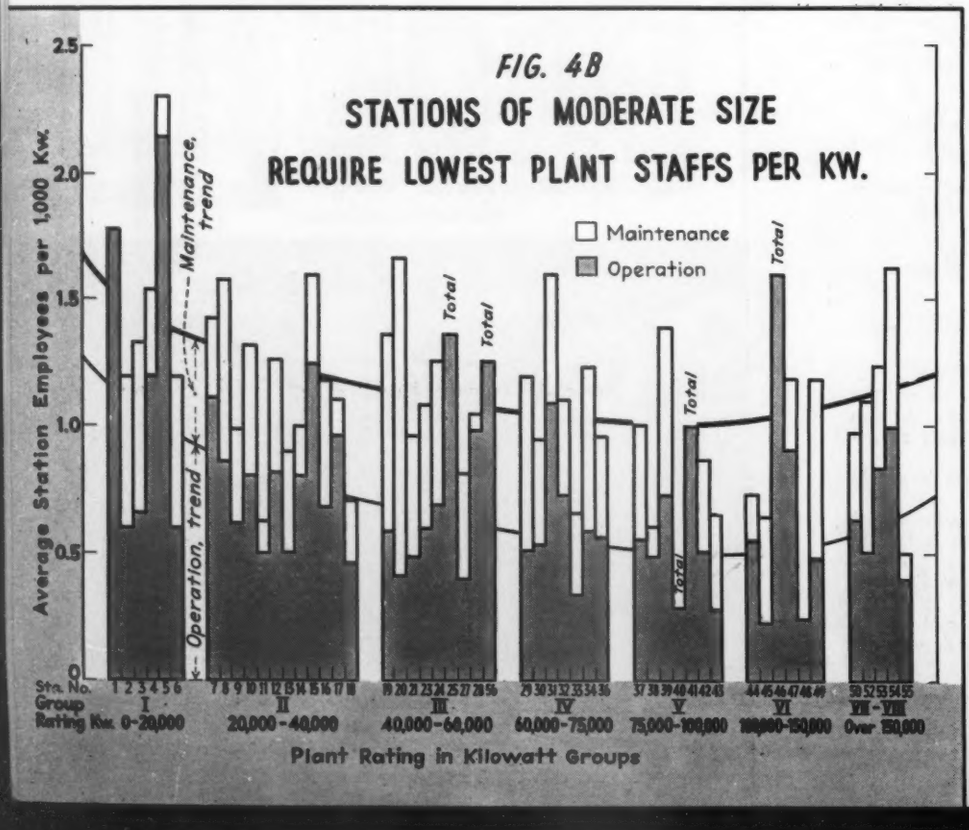


FIG. 4A
MAINTENANCE COSTS REDUCED
BY OPERATION AT BETTER PLANT FACTORS
Maintenance Expenses, Mills per Net Kw.-Hr.
Plant Factor
Total expenses for maintenance and repairs
Building, structures, maintenance supervision
Electrical equipment and auxiliaries
Prime movers and auxiliaries
Steam generation equipment and fuel handling



Looked at from the angle of employees devoted to maintenance, it appears that nearly half the station force is devoted to upkeep duties for plants in the range from 60,000 to 150,000 kw. (Fig. 4-B). For the smaller plants, which (as shown elsewhere) were operated at plant factors and utilization factors above the average, it appears that maintenance staffs constitute only a third of the total station staffs.

Perhaps more significant is the fact that fewer employees are being assigned to maintenance in small, well-loaded plants than in medium-sized plants less completely loaded. The largest of stations, situated in metropolitan areas, show more employees per 1,000 kw. of capacity for operation with but little relative increase for maintenance staffs.

A Look at "Little TVA"

Nebraska power districts reach completion stage — Variable water flow make power possibilities unknown — Limited market and high costs handicaps — Many influences at work make outlook dubious

L. W. W. MORROW, *Western Editorial Director*

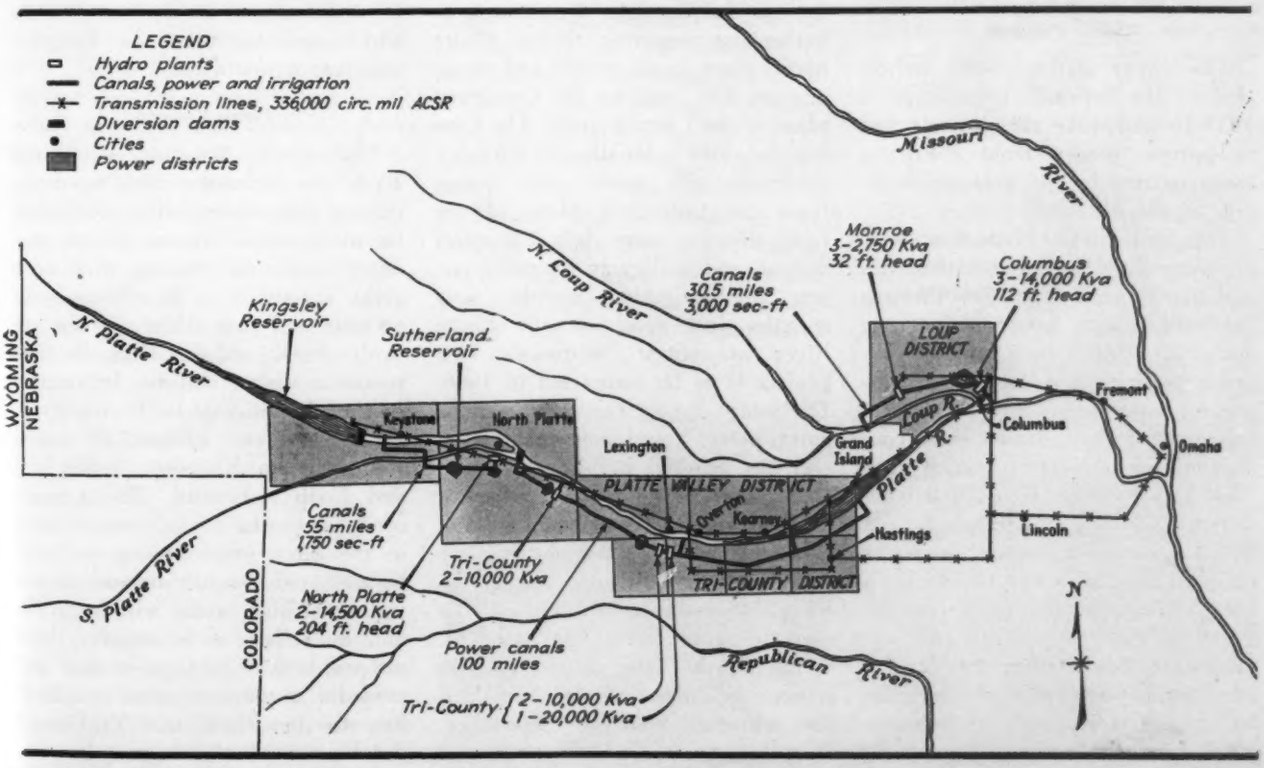
OUT in Nebraska there is a little "TVA" that has been greatly publicized and discussed. It consists of a group of power and irrigation projects that are political subdivisions of the state of Nebraska, each of which has used PWA money to develop power and irrigation projects. Funds allotted to date amount to $55,391,000 on the three major projects, of which $20,713,000 is in grants and $36,678,000 is in loans, bearing 4 per cent interest, which are to be repaid in 33 years starting in 1942.

The three major power districts are (1) Platte Valley or Sutherland, (2) Central Nebraska or Tri-County, and (3) Loup. The first two are irrigation and power districts on the waters of the Platte river and the third is a power project on the Loup River. The Platte and Loup projects are completed but the Tri-County is still under construction. Each of these districts is self-contained and independent as to ownership and management, but all are now tied together with a 115-kv. transmission system and all plan to co-operate in the use of water to produce power in Nebraska.

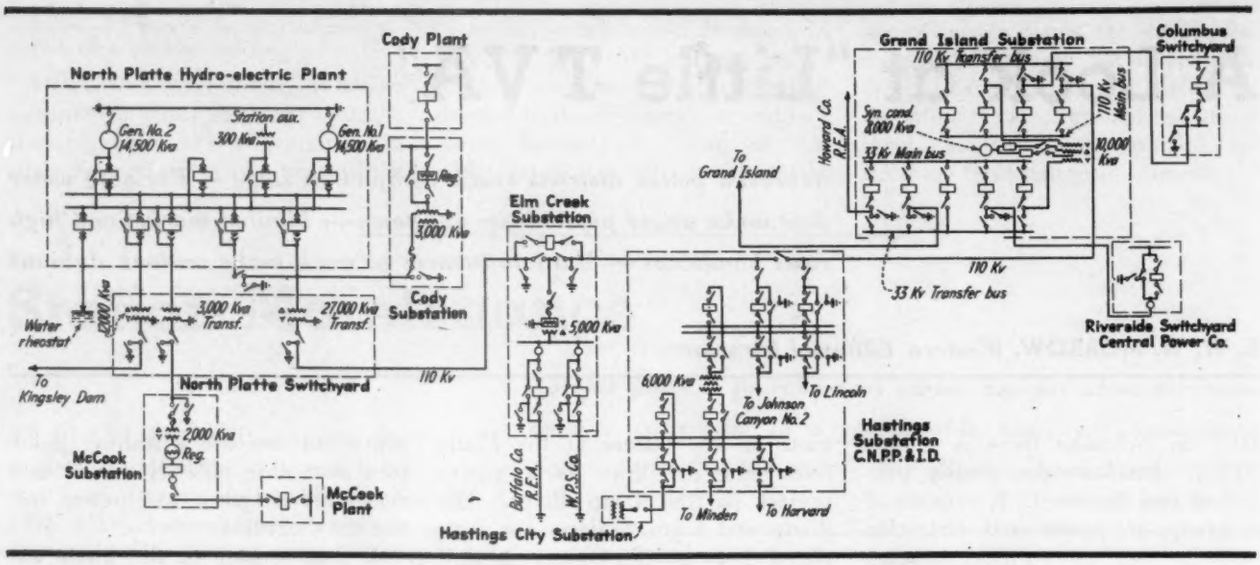
The Nebraska developments have been the subject of criticism from many angles—costs too great, power markets lacking, shortage of water and impracticable from an engineering point of view. In contrast, those who built the projects say they will prove out and are a starting point to a state-wide publicly owned and controlled irrigation and power system for Nebraska.

A final answer to the whole affair must await the future, but the status of the "Little TVA" at this time makes an interesting story, points the way to the future and affords evidence of the "blue sky" nature of the developments.

Land in the Platte River valley in central Nebraska needs water for irrigation in the central and western portions and all available water from the normal flow of the river has been used for irrigation for several years. Upon completion of the Tri-County and Platte projects it is planned to irrigate an added



Three Nebraska Power Districts with connecting transmission lines. Tri-County projects under construction. Transmission at 115 kv. except line from North Platte to Kingsley and Columbus to Monroe



Electrical layout from North Platte east to Columbus showing substations, lines and interconnections

250,000 acres of land and to develop the power available in the water. The basis of these two projects is to store the floodwaters in the spring in reservoirs and to take the stored water through canals to irrigation ditches and power plants. The Loup project, however, is on the Loup River in the central part of the state, where irrigation is not a normal necessity, and this uses stored water as a basis for water-power development.

State Projects

The power districts were authorized by the Nebraska Legislature in 1933 to undertake the projects and to borrow money from PWA on loans secured by the potential earnings of the districts.

Both the Loup and Platte rivers vary in flow greatly from month to month and year to year. They flow through flat valleys with sandy banks over underlying gravel beds, and the adjacent valley land has an underground water level only a few feet below the surface. Under these conditions it is necessary to carry water from the river in canals to the adjacent sand hills and thence a long distance in other canals to get a sufficient head of water to operate a power plant before returning the water to the river. Thus, all the projects utilize a diversion dam, a long canal system, storage and regulating reservoirs, and a discharge canal from the power houses back to the river.

Because of the distances it is uneconomical to line the canals, and thus open cuts in sandy porous soil were made and many difficulties because of drainage and irrigation ditches, seepage, erosion, slides and existing structures were encountered and still exist. Because of the terrain, shallow reservoirs covering a large acreage were built, and here again seepage, evaporation and erosion of banks put handicaps on the projects.

At the present time the Platte Valley has completed its diversion dam, Sutherland reservoir, North Platte hydro plant, canal system and transmission line east to the Columbus plant of the Loup district. The Central Nebraska is building its Kingsley reservoir with power that comes from the Columbus plant of the Loup district, more than 200 miles distant, and is digging its canal system for irrigation in the four counties just south of the Platte River in central Nebraska. This project is to be completed in 1940. The Loup district has completed its dams, power house and canal system and has finished building transmission lines east to Omaha, where a large substation is now being erected. Power from the Loup plant is going west to operate the dredges on the Kingsley reservoir and is used locally to supply some REA projects.

The North Platte project had no power available at the time of the editorial visit in September, this year, because of low water and its plant operates as a condenser on the line. The Loup plants also are now running on present available river flow of about 900 sec.-ft. and produce only sufficient power to operate the two dredges at Kingsley and to supply the local rural lines. Reservoirs at Sutherland and at Loup are empty and water available for power is about zero on the North Platte and only about 900 sec.-ft. on the Loup. Thus, at this customary low-water period, the firm power on the two systems in operation is only about 10,000 kw., of which 8,000 kw. is needed to operate the two dredges which are employed on Kingsley reservoir construction.

Firm Power?

The whole question of "Little TVA" in Nebraska lies in determining how much hydro power can be made available on a firm and dump basis on streams that have great variations in flow from year to year and just about dry up entirely every summer. Thus the firm power available will be determined by the magnitude of the spring floodwaters and the amount of stored water in the Kingsley, Sutherland and Loup reservoirs. The amount of storage water to be counted upon in the three reservoirs cannot now be answered, because no one knows just how much water will be available for storage each year and there are problems of seepage, erosion and evaporation that are yet to be solved. Key to the Platte and Tri-County developments lies in the stored waters of the Kingsley and Sutherland reservoirs and that of the Loup in

the amount of normal flow and the stored reservoir water in the summer and winter of each year.

It should be added that existing irrigation on the Platte has prior rights over the power districts and that the U. S. Reclamation Bureau is beginning to store water behind Seminoe Dam in Wyoming to irrigate 66,000 acres there from a new 1,070,000 acre-ft. reservoir in the headwaters of the North Platte. But the Colorado-Big Thompson project in Colorado contemplates diversion of Colorado River water into the South Platte, and this may permit more storage in Kingsley by supplying irrigation water in the lower Platte. These changes in the situation and the variable flow of the Platte make it difficult to say whether or not all of the 2,000,000 acre-feet potential storage in the Kingsley reservoir of Tri-County will be available for use to help firm the power possibilities of the Platte Valley and Tri-County plants and to supply the water needed for new irrigation projects.

Economics of Projects

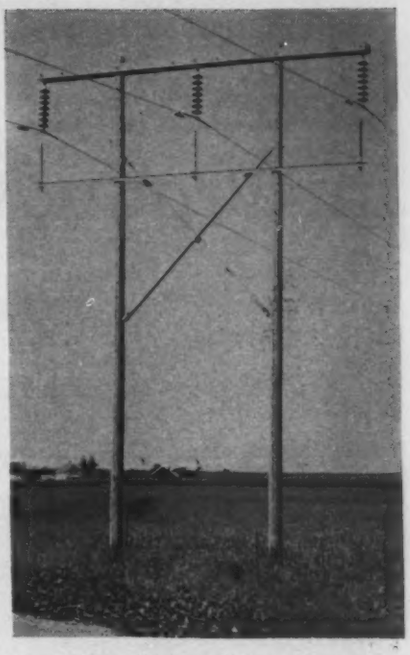
The "Little TVA" power possibilities have been greatly exaggerated. There will be relatively little firm power, a considerable amount of power over, say, an eight-hour period and a great deal of surplus or dump seasonal power that can be sold only for a very low rate even if markets are available. Present operations are negligible from a power production point of view and it is apparent that the generators already installed, and in contemplation, will operate on a low capacity factor even if a market for the potential power is found.

Each project stands on its own feet financially. On the Loup a total of $11,014,000 was advanced in three allotments by PWA, of which $7,798,000 represents a loan and $3,216,000 a grant. On the basis of the loan only, and with 49,250 kva. in the two plants, the installed cost is $159 per kw. Interest, amortization and operating expenses are about $870,000 per year. Estimated annual output of the plants is 188,000,000 kw.-hr., thus the average cost per kilowatt-hour is 4.6 mills. Last year the project produced 46,000,000 kw.-hr. and this year the output is expected to reach 90,000,000 kw.-hr., so the estimated output and cost are still to be realized. An assumption of a 40 per cent capacity factor for firm power is yet to be sustained and the rural load at about 1 cent per kilowatt-hour uses only about 3,000,000 kw.-hr. per year. This means that Loup firm power, if any, as well as its dump power, must be sold into markets in competition with existing power. With the necessity for standby local fuel plants and the cost of fuel for power in the area between 3 and 4 mills, it is difficult to see where Loup power can be sold at 4.6 mills per kilowatt-hour. It is quite evident that no opportunity exists for a reduction in rates in the area because of Loup power.

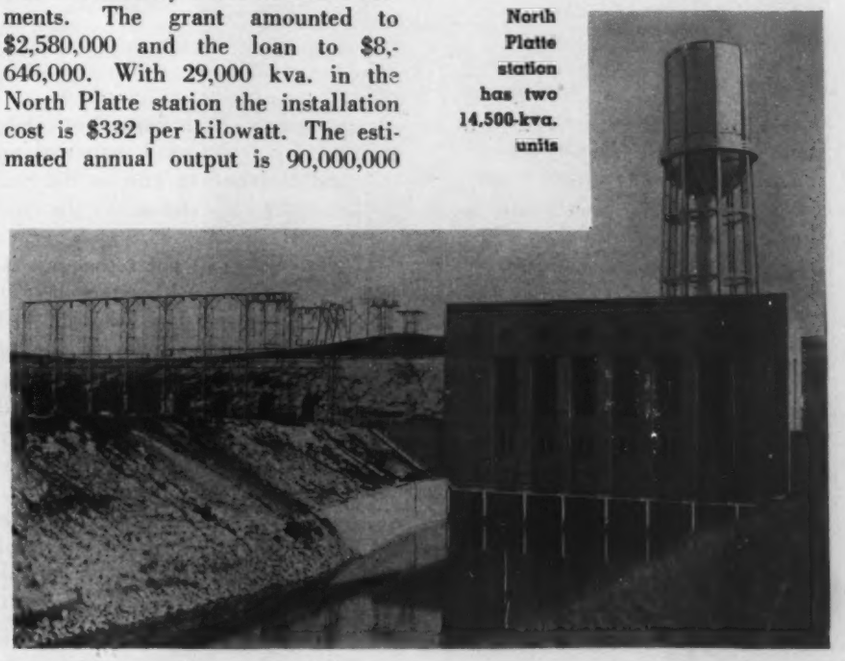
Within the last few weeks a contract has been made to sell Nebraska Power Company firm power in successive 5,000-kw. blocks over a period and a new power district called the Columbus district has been formed to take over the distribution system of Northwestern Public Service Company in Columbus on a lease-purchase basis so as to sell Loup power for use in Columbus. At the present time sufficient income was said to be coming into the Loup district to about cover operating expenses. On the basis of a good investment, however, the potential income affords insufficient margin to cover the financial requirements of the development.

On the Platte Valley, or Sutherland project, a total of $11,226,000 was allocated by PWA in four allotments. The grant amounted to $2,580,000 and the loan to $8,646,000. With 29,000 kva. in the North Platte station the installation cost is $332 per kilowatt. The estimated annual output is 90,000,000 kw.-hr. in electrical energy and an income of $100,000 is expected from irrigation water. Interest, amortization, maintenance and operating expenses are estimated at about $750,000 a year. This gives an average cost of energy of 7.2 mills per kilowatt-hour, giving credit for water sales. This plant is in an area where present electrical use is only 40,000,000 kw.-hr. a year, and thus at least half of this energy must be sent east a distance of more than

[*Continued on page 133*]



Wood-pole, H-frame, 115-kv. structure on Columbus-Omaha line. Expulsion fuses are used on each structure



North Platte station has two 14,500-kva. units

Conductor Properties Tested in "Production Line"

Copper thickness, ductility, strength of copper-to-steel weld, electrical conductivity and elongation are tested in every coil of Copperweld wire in new apparatus unit incorporated in production line

"Production line" unit for testing and inspecting Copperweld wire

Individual coils of finished wire enter the machine at the left end on wood supports laid across parallel conveyor chains. Before they exit via the overhead electric hoist at the right end the coils have been tested and inspected as to their electrical conductivity, copper thickness, ductility of copper and steel combination and completeness of weld, breaking strength and elongation. The machinery rising above the general level of the unit at the right pneumatically compacts the inspected coils to shipping size.

BY USING a conveyor system in its new testing and inspection department Copperweld Steel Company, Glassport, Pa., has been able to apply "production line" methods in testing and inspecting every coil of copper-covered wire produced. As an aid to accelerated production, this scheme permits the entire inspection process to be carried through with important savings in time and efficiency.

Coils Tested Two at a Time

Finished coils of wire enter the "production line" inspection unit at the left, or receiving end, and are carried through the machine on wood supports laid across parallel conveyor chains. Each inspection crew works as a team, each man making the test assigned to him as the coil is brought to his station by the conveyor.

Before the coils enter the unit itself, they (1) have been tagged, (2) the wire diameter has been checked at both ends and in the middle of each coil with a micrometer caliper and (3) each coil has been spread out on a wood support and visually examined for smoothness and freedom from surface imperfections.

Passing through the machine, each coil is first checked for its electrical conductivity—at both ends of the coil and, if necessary, in the middle—by comparing it with the conductivity of calibrated wires of equal diameter and length, using a millivoltmeter.

Next, the thickness of copper on every coil is electrically measured by a special instrument, which makes use of the fact that the layer of copper is non-magnetic and therefore acts the same as an air gap in a magnetic circuit.

Test Completeness of Weld

Pieces of wire from both ends of each coil are afterward bent back and forth in a vise until they break, the number of 90-deg. bends being counted and recorded; this determines the ductility of the copper and steel as well as the completeness of

the weld. In addition, the wire is sharply kinked in a double helix and a close inspection is made for any flaws on the surfaces of each helix.

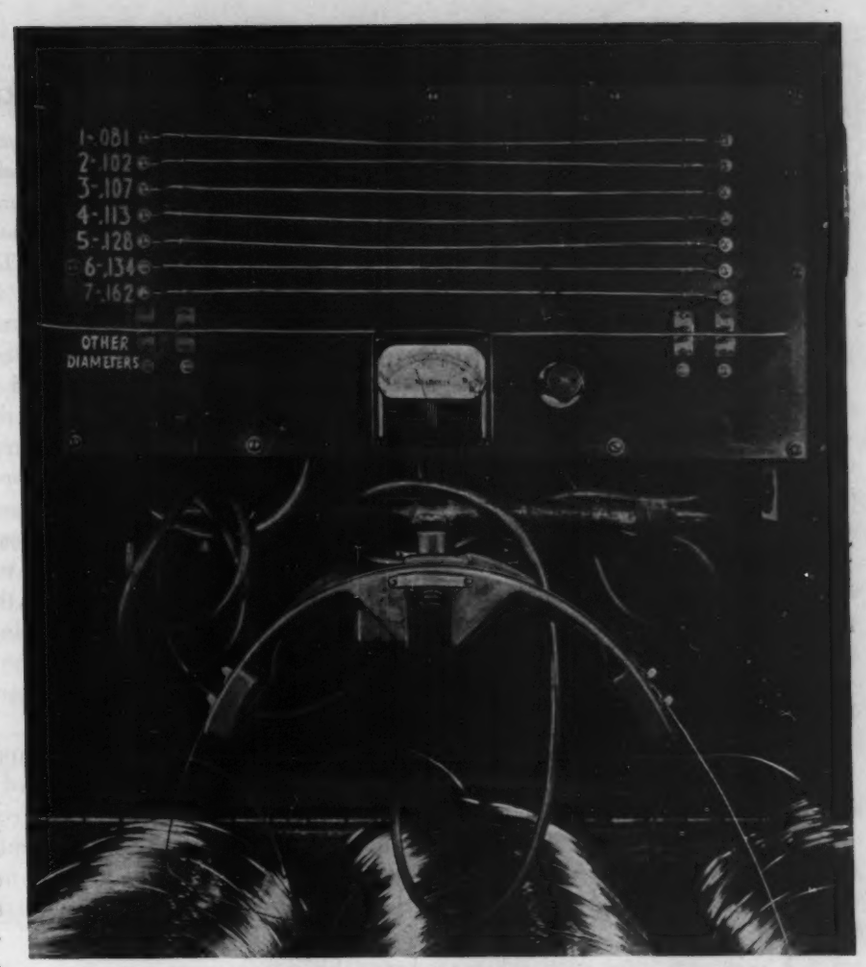
Pieces of wire from every coil are placed in a Tinius Olsen testing machine and pulled to destruction, a record being made of the breaking strength; the elongation is measured at the same time by an extensometer.

Finally, the coils, which have been spread out on the wood supports for convenience in inspection, are automatically compressed to shipping size and tied.

Electric Trucks Move Coils

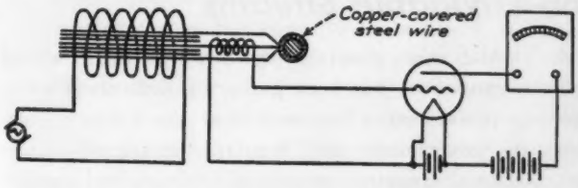
The overhead electric hoist then picks up the inspected coils from the right-hand or discharging end of the unit and piles them on electric trucks, which haul them to the storeroom or to the stranding department.

The new testing and inspection department was the last unit to be carried out in the plant expansion and improvement program authorized in 1938. This expansion work included the erection of an additional building with 28,000 sq.ft. of floor space to provide improved facilities for the casting department. Other improvements were the installation of additional annealing and heat-treating facilities, high-speed continuous wire-drawing equipment and high-speed stranding equipment.



Conductivity of the wire is checked with this instrument

Wire to be tested is looped across two contact points on the collar suspended between the instrument and the coil, the length between the contacts being the same as the length of the calibrated wires at the top of the instrument. Conductivity is read on the millivolt meter scale in the center of the instrument.



Left—General arrangement is similar in principle to ordinary transformer with loose electromagnetic coupling between primary and secondary. When sixty-cycle current flows through the primary circuit it sets up a magnetic flux in the probe, which in turn excites the secondary winding. Amount of magnetic flux can be increased by the presence of magnetic material at the end of the probe, thereby increasing the current in the secondary winding. Due to the shape and size of the probe, the increase of this flux can be made to depend mainly upon the distance between the end of the probe and the magnetic specimen, or, in other words, upon the thickness of the copper between the end of the probe and the steel core of the wire.

Right—Thin-end magnetic probe placed in contact with surface of wire indicates length of "air gap" or distance from non-magnetic surface of the wire to its inclosed steel core, providing a measurement of the copper at that point. Device is rotated around the wire to explore the thickness entirely around the steel core, this thickness being indicated on the meter in front of the inspector.

Thickness of copper is measured by an electro-magnetic method

Editorials

S. B. WILLIAMS, *Editor*

Another Anti-Utility Propaganda Barrage

BEFORE an army starts an offensive it generally lays down a devastating barrage which is expected to cripple the defenses of the opposition. That seems to be the tactics of the New Deal in its onslaughts against the utilities. Each time in advance of an attack there has come from the public power bloc a barrage of anti-utility propaganda.

A week or two ago another barrage began. Lilienthal at Alabama, Carmody at South Carolina, Norris and Rankin against Commonwealth & Southern, SEC Weiner and others went out of their way for no cause deliberately to heap abuse upon the utilities. Why?

This is all a prelude to an offensive that in all probability will bear no relation to the topics discussed in the above-mentioned diatribes. There are several things in the air. The point that we wish to make, however, is not that an attack is coming, but that the Administration finds it essential to prepare the public mind by further blackening of the character of an industry that was just beginning again to spurt ahead and lend its weight to improving the status of the capital goods industry.

It isn't going to be so easy now to besmear the utilities as it was five years ago. The public had been told both by the power companies and the government that when the utilities went to market in earnest the capital goods industries would awake and the depression would be over. Well, the utilities have started to go to town. The papers have been full of the wonderful strides of the power companies, of the turbines on order, of the hum of the electrical factories, of the stimulation of copper mining, etc.

And is the public going to be fooled by propaganda that would curtail this utility spending and further delay recovery? That depends, of course, upon how well the public continues to know which side of the bread is buttered.

When Streams Run Low

SUPPOSE the electric light and power industry, municipally and privately owned, had this autumn relied on the normal amount of available water power and had neglected to maintain an adequate backing of steam station capacity. The result might well have been catastrophic.

Rising industrial activity called in September for virtually the largest wholesale weekly power sales ever attained, exceeded only slightly in August and September of 1937. Due to the long-continued drought in various parts of the country, the output from water power in the same month dropped to 26.3 per cent of the total. For comparison, the annual average percentages in the past four years were successively 39.4, 34.9, 35.5, 37.4.

The upshot was that fuel-burning plants were required to deliver the largest output ever recorded, 4 per cent more than in the preceding month, nearly 9 per cent more than the previous maximum, in August, 1937, and close to 26 per cent above that of September a year ago.

What has happened once can happen again. Nature cannot be expected to play favorites, as between private and federal projects. Vast hydro-electric developments by the government are of little avail when the waters run low, however useful they may be under normal conditions. There must be enough capacity in steam to meet emergencies.

Federal Control Over Non-Navigable Streams

FOR YEARS the government, through the Federal Power Commission, has been gathering unto itself ever-widening powers over the waters of the country. In theory the government may regulate the use of waters where national defense, national or international navigation or commerce between states is affected. But the commission has more lately contended that its power extended over non-navigable waters, where it has generally been the law that the rights of the states are paramount.

For a hydro-electric plant on the New River at Radford, Va., the Appalachian Electric Power Company applied for a license from the commission covering only regulation of navigation, without any recapture or other financial or economic regulation. This was refused, although the Army engineers stated that navigation would not be affected. Operations were started without a license and an injunction was applied for by the commission. The injunction was denied in a United States district court and appeal was taken to the Circuit Court of Appeals.

This latter court has now upheld the lower court on the grounds that no need is shown for protecting

navigation and that it would be inequitable to force the power company to accept a license with conditions as to property rights which properly are subject to the regulatory laws of the state and not of the federal government.

The case and its adjudication is most interesting in showing the philosophy back of the government's desire for power over non-navigable streams. Constitutionally the government may not develop a stream for power. It may improve navigation or engage in flood control, but power must be incidental, not primary. However, if the government may grant a license and have it accepted, then the project can revert to the government after 50 years.

Through such means the government then becomes the owner of a hydro development that has no relation to navigation or flood control. The fact that the ownership of stream bed belonged in the state may later have to be threshed out in the courts seems to be no deterrent. The important thing is that the government seems determined to nationalize water power, even if it has to wait for 50 years.

Demand Meter versus Watt-Hour Meter Precision

DEMAND METERING is receiving increasing attention in certain regulatory areas on the general premise that if there is a demand component in the rate the demand should be metered and not estimated. That does not sound so illogical, but there is less logic in the tendency to expect and require almost as much precision in the demand meter as has come to be required of the watt-hour meter. Undoubtedly such accuracy can be attained by the manufacturers' designers if it has to be, but it looks very much as if it will be a choice between refined precision, high cost and high maintenance on the one hand, and on the other hand, reasonable accuracy, cost and economical maintenance.

One hears of government agencies that are asking for cheaper watt-hour meters (presumably condoning some sacrifice in precision) and hint at a liking for volt-ampere rather than watt metering. Possibly this trend away from the conventional should be welcomed if only as education to state regulatory authorities that the trend toward narrowing tolerances in meter accuracy has gone far enough.

To some it has always seemed incongruous to set a kilowatt-hour rate at 4, 4½ or 5 cents—as close as the limitation of cost allocation and the rate guidance will permit—and then proceed to meter to within tenths of a per cent. Likewise, demand rates are set to the nearest quarter dollar per kilowatt of monthly demand, and this may mean arbitrary steps of 12½ to 25 per cent. Why expect and require the demand to be metered to high precision just because it has become the habit with watt-hours? This matter of setting rates at convenient round-figure values and metering to fine points deserves discussion before the pattern of demand accuracies gets crystallized in the mold set traditionally for energy metering.

Are We Ready for Standardization of Station Equipment?

REVIVED ACTIVITY in providing generating facilities is likewise stimulating a lively program of station designing. ELECTRICAL WORLD'S Fourth *Steam Station Cost Survey*, in this issue, is thus fortunately a well-timed service to the industry. Those who urged us to make the study again this year, after only a two-year interval, sensed, as we did, the virtue in correlating performance and cost data for typical plants for the sake of the guide these may be to pending station designs. Managements evidently also recognized the value of having such information collated because they contributed data on nearly three times as many representative plants as were covered in the last survey.

These plants are of assorted vintages, varying size and location, use widely different fuels and steam pressures and temperatures. Some are now peak-load plants designed for base-load operation and *vice versa*.

Even with 56 diversified plants to compare and analyze there is none too much justification for drawing sweeping inferences as a guide to prospective designs. In fact, some of the indications are slightly contradictory. Nevertheless, there is undeniably food for thought in this extensive quantitative information. That is the spirit in which it is compiled and presented. Whoever uses it will want to modify the interpretation by considering his own land costs, system configuration, available fuel, system load characteristics, interchange connections, etc. Only then can he safely conclude whether thermal refinements will produce efficiencies and economies which warrant the extra expenditures they entail.

Outstanding among the unmistakable inferences from the survey is the high degree of uniformity in overall cost per kilowatt-hour shown when the plant performances are recomputed on a comparable basis of loading and output. The resultant range is so narrow that one may almost say that their designers had a common cost objective, and that this would have been attained could the plants have been operated to take full advantage of the inbuilt performance.

That definitely raises the question whether more standardization of equipment designs and ratings would at all hamper the latitude in assembly which should be accorded the designer to meet local conditions. When in the final analysis individuality of design produces so little, if any, advantage in production cost perhaps the time has arrived when savings can be made in fixed charges through the standardization of turbines, boilers and accessories.

Picking Up the Cudgels Again?

By CARTER FIELD

This noted journalist gives his personal comments and interpretations on current happenings affecting the electrical industry. His background and his location at Washington make his thoughts informative and interesting even though all may not agree with him

THE four horsemen of the public power Apocalypse, Dave Lilienthal, John Carmody, John Rankin and George Norris, are riding again. A gullible reporter in Washington will be told by all sorts of public power functionaries that it doesn't mean a thing—that it was pure coincidence that the four have been laying down a barrage against the utilities. Nobody in the high command, one may be assured, pressed any button which ended the truce which many neutrals had hoped would mark a permanent peace.

But it does not take a very cynical mind to conclude that there are just too many individual actions, and impending actions, and that they all fit together too precisely into a pattern for the whole conglomeration to be banditry instead of an organized military operation. The timing, also, is important. It comes on the eve of December 1, that final date for "integration" of the holding companies under the death sentence benevolently administered by Jerome Frank of SEC. It comes just a few weeks before the scheduled beginning, on December 11, of the monopoly committee's probe into investment trusts tied up with the utilities, from which, incidentally, the utility baiters hope for great publicity in that big names associated in the public mind with Wall Street and financial power are to be flashed, it is expected, on every front page in the country.

It comes just before the 51 utility executives, summoned to Washington by Harold Ickes, as head of the new National Power Policy Committee (successor of the recently purged Louis Johnson committee) are expected to reveal to a waiting public that this country is woefully unprepared for national emergencies in its power supply, especially in the lack of adequate interconnections.

Foxy Stuff

The strategy is even clearer when one realizes that the new Congress will meet in January—right after the public has been thoroughly shell-shocked by first the wickedness of the power barons, via the TNEC investigation, and the shameful unpreparedness from a military standpoint, as Mr. Ickes' lieutenants assure him will be demonstrated. On this last point there is supreme confidence ramifying down through the ranks of the whole public power bloc, despite the insistence of the utility men that the electric industry can stand any reasonably conceivable strain.

SEC is guarding its plans with a secrecy so intense that one wonders if anybody except Jerome Frank himself knows the details of its plan, which, it is admitted, will shortly be sprung and involves a forced "integration" system which will be the most colossal shifting of business equities in history.

TNEC's plans are fairly obvious, aimed only at whipping John Q. Citizen into line behind what the public power group wants from Congress.

Legislative Indecision

But there is a curious indecision in the general staff of the anti-utility forces as to what to ask Congress to do—how to cash in quickly on all this tremendous barrage and drive the country further down the road of complete socialism in the electric industry. As a matter of fact, there are a few pinks among the reds. The pinks would leave existing steam operations in private hands, only insisting that all hydro power should be public.

But the indecision is caused by lack of conviction that Congress will be amenable.

To the public power group the all-important immediate objective—aside from the SEC "integration" which they think is "as good as done"—is that big industrial loop plan. It was the only important question, apparently, at the first meeting of the National Power Policy Committee, over which Ickes presided. The scheme was put up to the now defunct National Defense Power Committee (the Louis Johnson outfit) by Thomas R. Tate, and is generally referred to among the faithful as the Tate plan.

Its idea is a gridding of the East, including New England, as far northwest as Wisconsin and as far south as Birmingham, with tremendous power lines connecting everything up, and four huge government built and operated steam plants for "emergencies." These four plants would be in the coal fields, respectively of Illinois, Ohio, West Virginia and Pennsylvania. The Tate plan's proposal for use of these steam plants would be to retire from use all privately owned steam plants which require more than 1.4 lb. of coal per kilowatt-hour.

The Johnson committee turned thumbs down on this Tate plan. It was not exactly rejected, but it was pigeonholed. The Johnson committee was aiming at preparedness through expansion of existing private systems, which, most people believe, is the reason there is now an Ickes committee in its place.

But this prime objective, so nearly perfect in the eyes of the public power crowd, has two objections. One is the fact that the only estimate so far made as to its cost to the federal government is $500,000,000 for the grid system alone and two billion dollars for the whole project. So that sort of thing is scarcely timely in view of the President's publicly announced intention of cutting expenditures.

But Snags Ahead

Even more important, however, is the fact that the alibi of the public power boys for this plan is national defense. If it went to Congress on that excuse it could hardly avoid going to the House military affairs committee. The chairman of this committee is Andrew J. May, who represents one of the big coal mining districts of eastern Kentucky, and he has been fighting government hydro projects so long that he has grad-

(*Continued on page 134*)

NEWS OF THE WEEK

New Attacks on Utilities Seen as Planned Drive

Secretary Ickes calls conference of utilities to study future power needs of the country — Government network seen proposed for eastern seaboard — Willkie answers charges

The open assault on the electric utility industry continues, with little signs of a let-up for some time. Opinion is expressed in many quarters that the concerted drive by the government power proponents in Washington is a planned campaign of many hues, one of which is to use the utilities as the "whipping boy" in the next political campaign.

Last weekend Senator Norris of Nebraska and his standby, Representative John Rankin of Mississippi, issued blasts against the industry. Maurice P. Davidson of the New York State Power Authority in a speech at Massena, N. Y., brought up his old subject of the St. Lawrence hydro-electric project by declaring that "its benefits will extend to every nook and corner of the nation."

Calls Conference

In the midst of the attacks, Secretary Ickes, chairman of the National Power Policy Committee, wrote to utility officials inviting them to a series of conferences to discuss methods of "meeting the country's future power demands." These meetings are to take place next week in Washington.

"The committee feels that the government and the power industry have a common interest in these problems and is eager to work out its plans in co-operation with you," Mr. Ickes wrote.

Utilities were asked to supply recent load data by months, the net energy available, the maximum demands and dates and hours of peak loads, the installed capacity, capacity contracted for and when to go into service, and a chart showing by years the dependable capacity of the system.

Mr. Ickes expressed the desire that this data be sent to the committee in advance so that it will not be necessary to hold more than one conference to reach an agreement.

Back of the plan is a scheme of a gigantic government power grid extending from the St. Lawrence down through important centers to the TVA. It would extend into the Middle West to Chicago and take in central industrial centers. Such a system would cost between $600,000,000 and $750,000,000. Since the private utility industry would be unable to finance such an undertaking, opinion is that the network would be financed by the government and, of necessity, operate in competition with the private utilities.

Build Own Plants

Another angle on the government scheme, observers point out, is that should the private companies be tied in to the system only those plants of high operating efficiency would be connected. In the absence of connecting the utilities, the government would construct its own steam-generating plants in strategic points to feed the system. This would be done as a war emergency.

The utilities have sufficient data on such a power system, as an Edison Electric Institute committee, composed of engineering executives of the Eastern utilities, has been discussing interconnections for many months (ELECTRICAL WORLD, September 30, 1939).

The Norris statement was inspired by a letter written by Otis & Co., Cleveland investment banking firm, to Wendell L. Willkie, president of Commonwealth & Southern Corp., offering to underwrite an issue of 125,000 shares of Consumers Power Co. common stock "at a price substantially in excess" of the $28.25 a share for which Consumers Power was to sell it to C. & S.

Senator Norris accused C. & S. "was putting across a raw deal" when it sought to purchase the stock. He also asked the Securities and Exchange Commission why it "has not compelled Commonwealth & Southern to comply with the terms of the utility act."

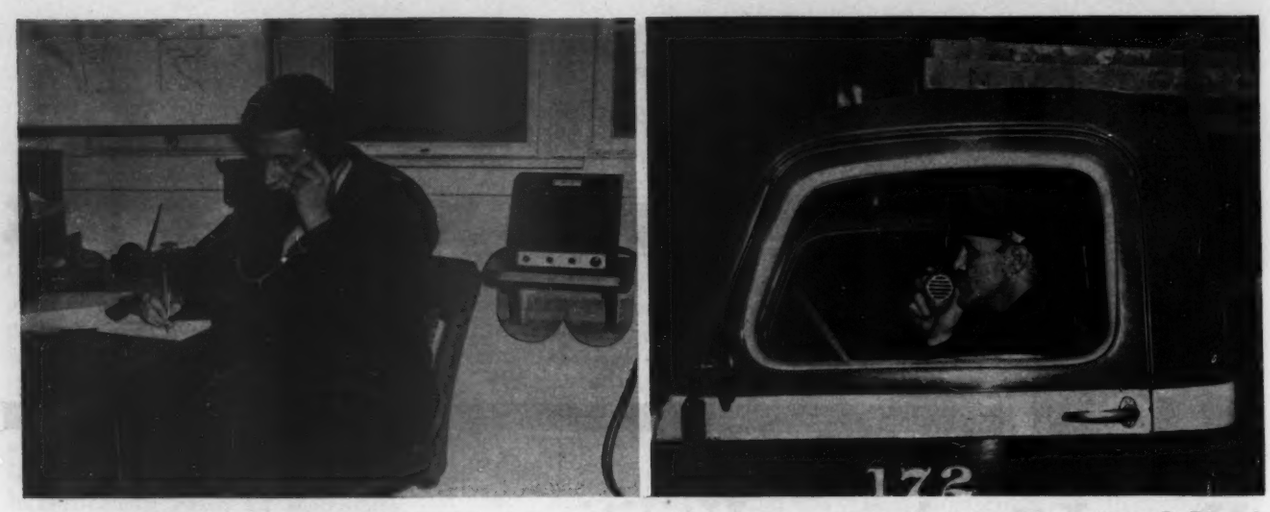
Willkie's Answer

Mr. Willkie said that the Michigan Public Service Commission had set the price for the Consumers stock and that the parent company has voluntarily, and for the purpose of building up Consumers Power, contributed within the last year almost $5,000,000 to the capital structure of the Michigan utility.

"There have been a number of statements recently by federal officials attacking the utilities," Mr. Willkie said. "It is perfectly apparent, in view of these and others recently released, that there is a deliberate and unprincipled campaign in process to smear the utility companies and their officials. The one explanation—and perhaps the kindest—of Senator Norris' extraordinary statement is that he is not familiar with the very ABC's of finance."

Mr. Rankin called upon the members of SEC to "enforce" the utility act or "get out." He demanded enforcement of the "death sentence" of the utility act.

On November 25 Federal Works Administrator John M. Carmody lashed the utilities in a speech before the Nebraska State Water Conservation Congress and praised the Nebraska "Little TVA," the dream of Senator Norris.



RADIO EQUIPMENT—Indiana Service Corp. has begun operation of its two-way emergency radio in Fort Wayne. James R. Edwards (left), supervisor of customers service, directs service cars in emergency. At right is service man receiving instructions while out in the field

Two-Way Radio Aids Indiana Utility Work

The Indiana Service Corporation began regular operation early this month of two-way emergency radio equipment at the company's power plant headquarters in Fort Wayne, Ind., having recently received authority from the Federal Communications Commission. The new radio equipment will enable dispatchers to talk to service men in their cars at a distance of about 18 miles from the plant.

The ISC is one of the first utility companies in the Midwest to install a short-wave radio station to handle emergency trouble dispatches. The company is licensed to flash orders to line truck and customer service cars by radio only when emergency service is needed in Fort Wayne and surrounding territory.

Quick Repairs

Radio-equipped trucks and cars will handle cases where wires or lines are down, resulting in hazards to the public, and maintain essential public service at hospitals, theatres, industrial plants, department stores and other places of public assembly.

The ISC station has been assigned call letters "WFIA." The antenna for the radio station is supported by a tower erected on the roof of the company's stores building. Total height from the ground to the tip of the antenna is 195 feet. The tower is lighted with red lights for danger signs to airplanes. It is designed so that a wind velocity of 100 miles per hour will stress the tower to only two-thirds of its strength.

At the present time two-way communication has been accomplished with line patrol trucks at distances of 18 miles from the main station. This range is expected to be substantially increased.

Recently an exceedingly strong wind caused limbs of trees to be blown across some of the company's wires, tearing them down. Service men were dispatched to these locations by the radio to protect the public from accidentally coming into contact with the fallen wires and to clear up the damage so that service could be restored. In another case service men were dispatched to the scene of a fire where pole lines were destroyed. Electric service was quickly restored by repairmen using the radio-service-equipped cars.

Willkie Gets Boom as U. S. President

Wendell L. Willkie, president of Commonwealth & Southern Corp., would make "a very strong candidate" and is an ideal business man for President of the United States, Gen. Hugh S. Johnson, former NRA administrator, told the Bond Club of New York last week. The General was sure that "with an intelligent government in Washington we could have prosperity tomorrow."

Mr. Willkie's comment on the suggestion as a presidential candidate was: "In view of the speed with which the federal government is taking over my business, shortly I'll probably have to be looking around for a new job. General Johnson's is the best offer I've had thus far."

Sales Drive Planned by Washington Utility

Make a campaign colorful enough and all will participate, is the opinion of Lewis A. Lewis, assistant general manager of Washington Water Power Co. in charge of sales, following an unusually successful range and water heater sales drive. During the campaign, which started last March 20 and closed on October 7, in which dealers and the utility participated, a total of 2,157 electric ranges and 2,010 water heaters were installed with an E.A.R. of $130,628.

The drive was divided into four periods with prizes awarded for individual, manager and division sales. Division Manager J. D. Lewis, who conducted a political campaign of the gay '90s, won the World's Fair trip and Gordon DeFoe, Lewiston division sales manager, won high honors among sales heads.

During the drive sales interest was stimulated by promotional material, radio spots, billboard and newspaper advertising.

The company plans to sell at least 3,500 ranges and 3,000 water heaters next year. The average residential consumption is now 2,011 kw.-hr. and moving higher.

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Bonneville Steel Report

An analysis of the feasibility of establishing an iron reduction and steel industry in the Pacific Northwest has been undertaken by the Bonneville Power Administration. Administrator Paul J. Raver is expected to submit a report to Secretary Ickes in the near future.

FPC Policy Gets Setback In New River Decision

Court holds commission has no jurisdiction over $10,000,000 Claytor Dam project near Radford, Va. — Because of its importance, an appeal to U. S. Supreme Court is likely

The drive of the Federal Power Commission to extend its jurisdiction over all waters of the United States that are used by private utilities in developing water power sites received a severe setback recently in a decision handed down in Baltimore by the Fourth Circuit Court of Appeals.

Failing to force the Appalachian Electric Power Co. to obtain a "major" license for its recently completed $10,000,000 Claytor Dam on the New River near Radford, Va., the FPC will probably appeal to the Supreme Court for a review of the Circuit Court decision, written by Judge W. Calvin Chesnut, with whom Judge Elliott Northcott concurred and Judge John J. Parker dissented.

Affirms Lower Court

Affirming the decision of Federal Judge John Paul in April, 1938, the Circuit Court refused to enjoin the utility in the construction and operation of its hydro project. The court held that "where the interests of navigation are not involved (and where the United States does not itself possess property rights) the control of the use of the flowing water and the rights therein of riparian owners are subject to the laws of the several states."

The FPC had contended, as in other cases, that it had jurisdiction over all non-navigable streams whose waters may find their way into a navigable river, that it might have been navigable in the past or may be in the future.

In this case Judge Chesnut held that the New River was not navigable interstate from Virginia to West Virginia and that building the dam would not impair the navigation of the Kanawha River in West Virginia, into which the New River flows. It was also held that the Radford Dam would aid rather than hinder operations of the proposed federal Bluestone Dam project for flood control at Hinton, W. Va.

This case started June 26, 1925, when the predecessor company, New River Development Co., filed declaration of intention to build the dam. The FPC made an investigation and on June 1, 1927, found the New River to be non-navigable, but in time of low water the plant might affect navigation and that the company take out a standard license. Other investigations and hearings were held while the utility maintained that it would accept a license containing navigation and flood control provisions, but none pertaining to rates, recapture and any other jurisdiction of the FPC. This was refused.

Suit Against FPC

Desiring to go ahead with its project, Appalachian Electric Power on June 8, 1931, filed suit against members of the FPC to remove a cloud on the title of its land and to restrain interferrence with the use of its property. This case was dismissed for lack of personal jurisdiction over the defendants. The FPC then ruled that the river was navigable within the definition of the Federal Water Power Act.

The utility later notified the commission that it was proceeding with its project and on June 1, 1934, started construction. After some work had been done the FPC sought an injunction to stop work and operation until a license was obtained. This case was tried in the Federal District Court at Roanoke, Va., in December, 1936, and after six weeks the court handed down a decision upholding the utility. This decision was appealed to the Circuit Court last August and on November 6 the court upheld the lower court, sustaining the utility.

The court held that the New River is not navigable and that "federal legislation with respect to navigable waters is permissible only when it has some real and substantial relation to the control of navigation."

Since the utility had complied with the state laws and had received license, including the recapture clause, the court held that the FPC "has no valid authority to impose conditions which in effect give the ultimate right of ownership of hydro-electric projects in state waters to the United States and thus take it from the state."

Since this decision is of such far-reaching importance and goes counter to the trend of thinking in the commission, it is likely that an appeal will be made to the Supreme Court.

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Grand Jury Indicts Two Utility Officials

The federal grand jury in St. Louis has returned two indictments charging Albert C. Laun, former vice-president of Union Electric Co. of Missouri, and Frederick J. Martin, a sales engineer for the utility, with perjury committed during an investigation being conducted by the SEC into the business practices and financial conditions of the company and its subsidiaries and the St. Louis County Gas Co. Bonds of $5,000 have been posted. The SEC started its inquiry into the affairs of the utility last spring.

The charges are based on alleged

CLAYTOR DAM—The Fourth Circuit Court of Appeals has ruled that Appalachian Electric Power Co. need not have a Federal Power Commission license to operate its recently completed $10,000,000 hydro-electric project on the New River

false testimony given by the two before examiners for the SEC. The indictment charges that Mr. Laun denied having made contributions of company funds to aid political candidates, having offered financial aid to candidates or solicited candidates to run for the Legislature, having worked for or advocated the election of particular candidates. The indictment against Mr. Martin charged that he testified falsely with regard to political activities against a proposed municipal ownership project in St. Charles County, Mo.

Union Electric has claimed that the St. Charles Circuit Court has no jurisdiction in the corrupt practices charges filed by Prosecuting Attorney David A. Dyer. This charge by the county is the outgrowth of charges that the utility contributed funds and aid to political candidates.

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Aiken Warns Utilities to Build New Lines

Vermont Governor says farmers want adequate service and proper rates

Gov. George D. Aiken of Vermont last week warned the fifteenth New England Conference Governors' session that farmers "will not hesitate to align themselves with the federal government in operation and control of electric plants and lines unless they get adequate service and proper rates, and get it soon."

A strong advocate of private enterprise in the utility industry, Governor Aiken said that New England farmers already "are taking things into their own hands" and have built hundreds of miles of electric lines serving communities that "remain sparsely populated because they lacked the means of providing comfortable homes."

Some private power corporations, he declared, make 20 to 30 per cent profit a year, "yet there are still tens of thousands of New England farmers without the services of electricity because extension of lines into their territory" would cost too much because of "inflated capitalization."

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Utility Union Wins

The NLRB has certified Union of Employees of the Iowa Southern Utilities Co. as the exclusive bargaining representative of all production and maintenance employees in the fifteen divisions. The employees' union, in a secret ballot, received 150 votes, against 40 for the CIO and 77 for the AFL unions.

Preferred Stock Arrears Utility and SEC Problem

Weiner recommends recapitalization of companies where earnings are too small to make up payments in report to commission — Accumulated dividends on outstanding issues total $372,487,414

Recommendations of recapitalization of those public utility operating and holding companies with arrearages so great in relation to the earnings available for preferred stock dividends that it is unlikely that they will be able to clear up payments were made last week by Joseph L. Weiner, director of the public utilities division of the SEC, in a report to the commission.

Mr. Weiner said that one of the major financial problems confronting a large part of the utility industry arises from arrearages on outstanding issues of preferred stock.

Some Can Pay Out

"There are a number of operating companies and some holding companies which undoubtedly should be able to clear up their arrearages without recapitalization," Mr. Weiner said. "However, there are some operating companies, and to a greater extent holding companies, where the arrearages are so great in relation to the earnings available for preferred stock dividends that recapitalization is inevitable."

It was pointed out that studies indicate that there are at least twenty holding companies with consolidated assets aggregating about $6,500,000,000 which must be recapitalized. The financial reconstruction of companies with unsound capital structures is one of the most pressing problems facing some of the holding company managements and the SEC, Mr. Weiner declared.

The report of Mr. Weiner included an analysis of 518 preferred stock issues with an involuntary liquidating value of $4,206,365,075, of which $3,590,730,690 was held by the public. Of the latter amount $2,010,082,274, or 56 per cent, had no arrearages. The remaining $1,580,648,416 was in arrears to the extent of $372,487,414, or 23.6 per cent of the liquidating value of the stock in arrears. Mr. Weiner pointed out that two systems in the Electric Bond & Share group accounted for slightly more than 25 per cent of the aggregate arrearages and that Standard Power & Light system accounted for another 10.6 per cent.

Of the $2,082,650,314 holding company preferred stocks held by the public, $1,168,911,229, or 56 per cent of the preferred stock issued by such companies, were in arrears. The arrearages accumulated on holding company issues totaled $282,519,592.

There was outstanding $1,508,080,376 of preferred stocks of operating companies held by the public, of which $411,737,187, or 27 per cent, was in arrears, on which $89,967,822 had accumulated.

Intra-System Holdings

Of $615,634,385 involuntary liquidating value of stocks held intra-system, the total in arrears was $369,649,448, or 60 per cent. Holding company stocks in arrears totaled $230,896,121, against which arrearages of $80,002,606, or 34.6 per cent, had accumulated. Intra-system operating company preferred stocks in arrears totaled $138,753,327, with accumulated arrears of $57,909,634, or 41.7 per cent.

The analysis showed that in 1938 registered holding companies and their utility subsidiaries paid an aggregate dividend of $148,129,723 on publicly held preferred stock with annual requirements totaling $214,808,000. The 144 holding company issues had annual requirements of $123,158,476 on publicly held stocks, of which $67,437,999 was paid in dividends.

Of the 1,370,550 public investors in stocks analyzed, 594,490 owned holding company issues and 776,060 holding operating company issues. There were 213,662 who held holding company stocks in arrears and 255,006 who held operating company stocks in arrears.

The study did not include issues of American & Foreign Power, Cities Service Co., Niagara Hudson Power, Pacific Gas & Electric and Public Service Corp. of New Jersey.

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Will Build Line

Washington Water Power Co. plans construction of a transmission line and distribution to Conconnully, in Okanogan County, Wash., at a cost of $12,000.

Profit-Sharing Plan Seen Aid to Utilities

Wisconsin Public Service Commission chief says suggested proposal would make for greater flexibility in rate making — Customers and utility should share in rising profits — Cites five main points

A profit-sharing plan of rate-making procedure for utilities would make for greater flexibility in rate making and tend to keep utility rates more in line with the level of other costs, in the opinion of A. R. Colbert, chief of Accounts and Finance Department of the Wisconsin Public Service Commission. Mr. Colbert said that this would be true whether the general level of prices increases or decreases. "In either event," he said, "the plan would probably decrease the time lag in changes in utility rates as compared with other costs."

Mr. Colbert suggested to the Wisconsin Utilities Association at its recent meeting that some thought be given to a profit-sharing plan, somewhat along the so-called Washington Plan. It is his thought that the utilities and customers should share in revenue growth.

Depreciation

As far as the depreciation problem in rate-making procedure is concerned, Mr. Colbert thinks that a profit-sharing or sliding-scale arrangement would do much to eliminate the controversial side of the subject. Such a plan, he says, after having been adopted, "would leave only the depreciation expense to be determined." He said:

"We have found that where this is the only determination to be made, agreement between utility and commission representatives is fairly easy. During the past year and a half this commission has certified, or is in process of certifying, annual rates of depreciation for the bulk of electric plants in Wisconsin. In each case agreement has been reached in conference as to the depreciation rates and no hearings thereon have been necessary. Perhaps the success in this respect may be due in part to the fact that the certifications of depreciation rates have been made in separate proceedings in which the service rates were not involved."

Mr. Colbert thinks the most simple, direct and practical plan of disposing of the depreciation controversy is to discontinue the use of reproduction cost new estimates, whether prices go up or down; for utilities to recognize the equity in the principle that when amounts are charged customers for depreciation expense, the rate base should be reduced thereby, and for commissions to recognize the need for compensatory returns on the capital, both borrowed and proprietary, reasonably and properly invested in the utility enterprise.

"After all," Mr. Colbert says, "it is not so much a question of the rate base or the rate of return as it is of the total dollars of revenue which is needed for the utility to fulfill its public service functions and to cover its costs, including both operating expenses and proper return on capital."

Speaking facetiously, Mr. Colbert said, "I offer my telephone number as a rate base for any utility if I may likewise fix the multiplier or rate of return to be applied to that number in determining proper aggregate revenues to be applied in service rates."

Profit-Sharing Plan

Mr. Colbert's plan follows:

1. Establish the total revenues which a utility is entitled to charge in rates as the sum of operating expenses, including depreciation and taxes, interest charges, preferred dividends and a stipulated percentage of the book value of common stock.
2. At the end of the year, or such other period as might be mutually agreed upon as proper under the circumstances of the case, if the percentage earned on the book value of the common stock exceeded the agreed upon percentage, rate reductions would be made. These reductions would be on a graduated basis, only a part of small excess earnings being so used, with the portion of excess earnings applied for rate reductions increasing gradually as the return on common stock equity increased over the agreed upon percentage of return.
3. Establish by stipulation a maximum percentage return on common stock equity and adjust rates so as not to exceed such maximum.
4. If percentage returns on common stock equity were less than the agreed upon percentage rate, increases would follow upon application of the utility.
5. Provide for periodic review of the agreed upon basic percentage return on common stock equity so that it would not get out of line with the money market. The intent should be that with a properly capitalized utility the percentage return would permit common stock financing to be done on the basis of its par value or its book value, whichever was appropriate in a particular case.

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War Halts New Plant

Owing to the outbreak of war the British Columbia Electric Railway Co. has temporarily postponed its plan to proceed with the erection of a new auxiliary steam plant at Brentwood Bay, near Victoria, B. C. The project was estimated to cost about $1,000,000.

REDEVELOPED HYDRO—Central Maine Power's 7,000-hp. installation at Solon on Kennebec River, with a Smith-Kaplan wheel and G.E. generator, recently placed in service and designated the Williams Station in honor of vice-president and general manager George S. Williams. An old and inefficient dam and turbine installation have given place to a modern layout.

Plattsburg Wins Suit to Get Power System

The New York State Court of Appeals has sustained the right of Plattsburg to issue up to $269,000 in bonds for the purpose of erecting a federal-aid municipal electric power plant. New York State Electric & Gas Corp. had sought an injunction to prevent the city's action, contending that building the plant would be a waste of public funds, and that, if bonds were issued, it would violate a local law.

Expecting a PWA grant of $234,000, the city was prepared to issue bonds for the balance of $286,000. The Appellate Court had ruled that the city's debt limit was $457,000 and established a present borrowing capacity of $83,230.

The Court of Appeals held that the city's debt limit is $269,000 instead of $82,320, which will allow the city to issue bonds for the power system. The system is to cost $520,000.

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Hold Thurston Centennial at Cornell University

Representatives from technical societies in England, France, Germany and Canada were among the delegates from more than 60 organizations and educational institutions who took part in the celebration of the hundreth anniversary of the birth of Robert Henry Thurston at Cornell University on October 25. More than a thousand persons attended the celebration.

During the convocation Bancroft Gherardi, a student of Thurston at Cornell, unveiled an oil portrait of Dr. Thurston and presented it to Cornell University. During the day Cornell exhibited a comprehensive selection of Thurston's publications, featuring the Centennial Edition of "The History of the Growth of the Steam Engine," and several pieces of laboratory apparatus and research material showing Thurston's skill in design and in scientific inquiry.

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Governor Olson to Push Public Ownership Drive

At the ground-breaking ceremonies at the government's Friant Dam, second major unit in the Central Valley water project in California, Governor Olson made a plea for public ownership.

"Your state administration has made, and will continue to make, every possible effort to secure passage of legislation enabling and facilitating public ownership," Governor Olson said. "This will make easier the formation of public utility districts and other co-operative enterprises whereby the farming communities of the Sacramento and San Joaquin valleys can insure getting Central Valley water and Central Valley power at the lowest possible costs."

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Allows System Purchase

The Wisconsin Public Service Commission has approved the purchase of the dam and other properties of the Oconto River Power Co. by the Wisconsin Michigan Power Co. for $90,000.

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Elect New Officers

At the recent meeting of the electric section of the Wisconsin Utilities Association at the Schroeder Hotel, Milwaukee, E. H. Finkelnburg, Mississippi Valley Public Service Co., Winona, Minn., was elected chairman of the technical division and C. F. Dobson, Wisconsin Power & Light Co., Madison, vice-chairman. M. D. Hagen, Wisconsin Hydro Electric Co., Amery, was elected chairman of the commercial division and R. E. Krafve, Superior Water, Light & Power Co., Superior, vice-chairman.

MEETINGS

Edison Electric Institute—Prime movers committee, Philadelphia, Pa., December 4-5; Detroit, Mich., February 5-6.

American Society of Mechanical Engineers—Annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa., December 4-8. C. E. Davies, national secretary, 29 West 39th St., New York, N. Y.

Seventeenth Exposition of Chemical Industries—Grand Central Palace, New York, N. Y., December 4-9. Charles F. Roth, president, International Exposition Co., Grand Central Palace, New York.

Petroleum Electric Power Club—Eleventh annual conference, Texas State Hotel, Houston, Tex., December 14-15. H. E. Roberts, secretary and treasurer, Box 792, Joplin, Mo.

Louisiana Engineering Society—Annual meeting, St. Charles Hotel, New Orleans, La., January 12-13. A. M. Hill, secretary-treasurer, 422 St. Charles Hotel.

American Institute of Electrical Engineers—Winter convention, New York, N. Y., January 22-26. H. H. Henline, national secretary, 33 West 39th St., New York, N. Y.

American Society of Heating and Ventilating Engineers—Annual meeting and International Heating and Ventilating Exposition, Lakeside Hall, Cleveland, Ohio, January 22-26. Charles F. Roth, president International Exposition Co., Grand Central Palace, New York.

Iowa Public Utilities Association—Annual sales and distribution school, Hotel Fort Des Moines, Des Moines, Iowa, January 29-30. Herbert Henderson, secretary, Security Building, Cedar Rapids, Iowa.

National Electrical Manufacturers Association—Mid-winter Conference, Waldorf-Astoria Hotel, New York, N. Y., February 5-9. W. J. Donald, managing director, 155 East 44th St., New York, N. Y.

Missouri Association of Public Utilities—Annual convention, Elms Hotel, Excelsior Springs, Mo., April 17-19. Jesse Blythe, assistant secretary, Merchants Bank Bldg., 101 West High St., Jefferson City, Mo.

Electrochemical Society—Spring meeting, Galen Hall, Wernersville, Pa., April 24-27. Dr. Colin G. Fink, secretary, Columbia University, New York, N. Y.

Bellows Falls Hydro Hearings Concluded

Hearings before Examiner Edward D. Marsh at Springfield, Mass., for the purpose of establishing the right of the Federal Power Commission to license the Bellows Falls Hydro-Electric Corp. have been concluded. Written briefs must be filed on or before January 15, 1940.

Witnesses for the FPC alleged that the weekend shut-downs of the company plant menaced navigation on the lower reaches of the Connecticut River as a result of the storage of water by the dam operated by the utility.

The FPC sought to show that the storage of water affected navigation and that navigation was an established practice on the river. Col. Frederick H. Paine, Assistant Secretary of War, 1930-33, stated that in the opinion of the engineers of the Providence, R. I., office, under whose jurisdiction the Connecticut River falls, the river was not a navigable stream above Greenfield, Mass.

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Porcelain Enamel Group Names McBride President

P. B. McBride of the Porcelain Metals Corp., Louisville, was elected president of the Porcelain Enamel Institute for 1940 at the organization's annual meeting, held recently in New York City.

A stimulating program provided the enamelers with many interesting new slants on sales promotion, development problems and color and design engineering. G. E. Henry of Designers for Industry, Inc., delivered a paper on "Design of Household Appliances," written by Charles H. Oppenheimer of the same organization, who was unable to be present. Mr. Oppenheimer described the combination home appliance of the future, consisting of a range, refrigerator and water heater in one unit; also in combination with this there might very well be a sink, dishwasher, incinerator and storage cabinets to make a single all-purpose wall in the kitchen.

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A.S.A.E. to Hold Meeting

The American Society of Agricultural Engineers has scheduled its fall meeting for December 4-8 at the Stevens Hotel, Chicago. Extensive programs have been prepared devoted to power and machinery, rural electrification and soil and water conservation. Raymond Olney, St. Joseph, Mich., is secretary.

Energy Dip Reflects Holiday, New Style

As is usual in the week that embraces Thanksgiving Day, the output of the electric light and power industry during the week ended November 25 fell off somewhat compared with recent figures, but with the production of 2,481,882,000 kw.-hr., as reported by the Edison Electric Institute, the lead over the like period a year ago expanded to 13.6 per cent.

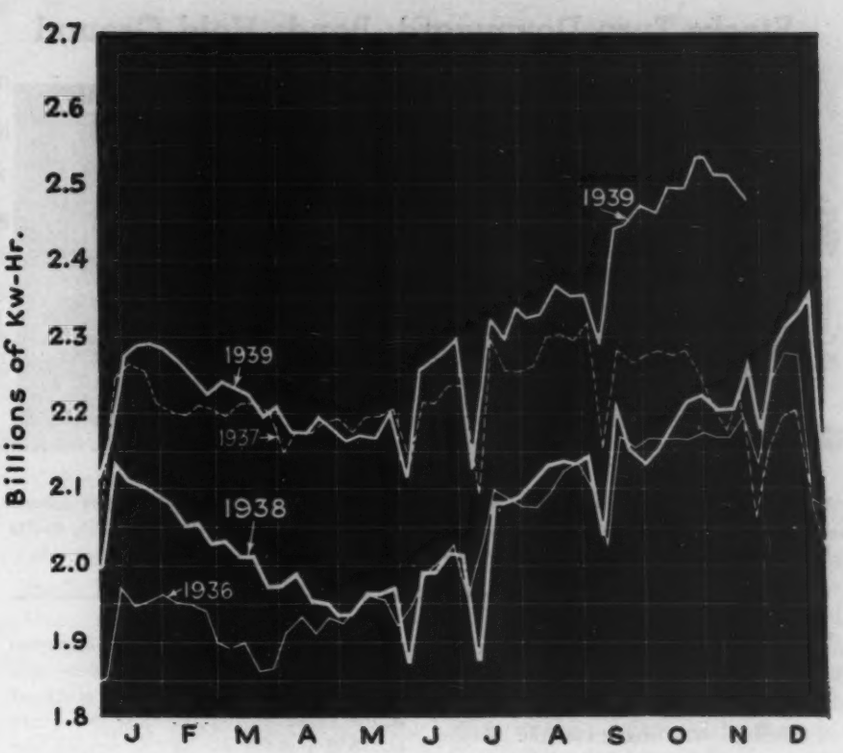
The gain, however, somewhat overemphasizes the increase in activity over 1938, for it is due in part to the fact that celebration of the holiday is this year divided between two weeks, so that a portion of the effect will be reflected in the next week's returns.

Weekly Output Millions Kw.-Hr.

1939		1938		1937	
Nov. 25	2,482	Nov. 26	2,184	Nov. 27	2,065
Nov. 18	2,514	Nov. 19	2,270	Nov. 20	2,224
Nov. 11	2,514	Nov. 12	2,209	Nov. 13	2,177
Nov. 4	2,537	Nov. 5	2,207	Nov. 6	2,202
Oct. 28	2,539	Oct. 29	2,226	Oct. 30	2,255
Oct. 21	2,494	Oct. 22	2,215	Oct. 23	2,282

Per Cent Change from Previous Year

	Week Ending		
	Nov. 25	Nov. 18	Nov. 11
New England	+19.6	+ 8.3	+14.3
Middle Atlantic	+ 9.5	+ 9.8	+11.9
Central Industrial	+16.0	+13.5	+15.9
West Central	+ 8.8	+ 7.5	+ 7.2
Southern States	+14.0	+12.2	+13.8
Rocky Mountain	+ 6.4	+ 5.4	+ 8.7
Pacific	+ 6.8	+ 8.0	+10.6
United States	+13.6	+10.7	+13.8



Adherence to the "old-style" date is statistically revealed, most conspicuously, in New England, where the gain over a year ago jumped to 19.6 per cent, against an average of 12.6 per cent for the four preceding weeks. In the Central Industrial region the rise to 16.0 per cent, despite disturbed conditions in the automobile industry, also suggests the effects of a divided holiday. Other regions show no striking changes.

Alabama Power Plans $6,165,000 Budget

Alabama Power Co. has set aside $6,165,000 for construction during 1940, according to Thomas W. Martin, president. This will be the largest yearly expenditure since pre-depression days.

Mr. Martin said that more than $1,000,000 will be spent for extension of rural service, $2,000,000 for further improvement to power supply for Mobile and for the new steam plant and more than $3,000,000 for transmission and distribution, including $347,000 in the Montgomery and $160,000 in the Tuscaloosa districts.

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Dynamite Pole Line

South Bend authorities fear the series of dynamiting of high-tension power line towers in recent weeks, culminating with the blasting of an 85-ft. tower near Arcola in northern Indiana, on the line of Indiana & Michigan Electric Co., extending from the substation north of Fort Wayne to the Deer Creek substation near Marion, is the work of saboteurs. Thomas F. English, vice-president, said he had "not the remotest idea" why the blasts were set off and reported a total absence of labor trouble.

Indiana police are intensifying an investigation of recent attempts to destroy high-voltage transmission lines of the Indiana & Michigan Electric Co. On November 24 eight dynamite charges were placed under 85-foot towers of the company near Ligonier, Ind., and 14 miles away near Diamond Lake. A motive is being sought for the series of tower blastings.

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Asheville, N. C. in Darkness As Utility Workers Strike

Asheville, N. C., was thrown into darkness last Tuesday when employees of Carolina Power & Light Co. walked out because the company officials refused to grant a closed shop. Service was restored early Wednesday. None of the power or substation men went out. About 60 of the 235 linemen, maintenance and service employees were out. Public sentiment in the area is against the strike.

Canada Considers Plans of St. Lawrence Project

Negotiations are now in progress between the Ontario government and the government at Ottawa with respect to an agreement concerning the construction of the St. Lawrence waterway and power project. It is expected that the agreement will be signed in the near future.

Support to the project has taken on new interest in Washington, where efforts are being made to bring the subject before Congress next year. The St. Lawrence project will constitute one end of the gigantic power interconnection system which Washington power proponents now have under consideration.

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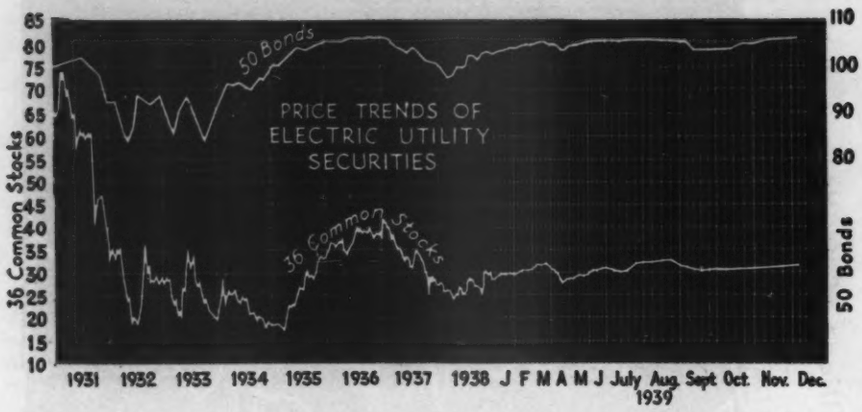
New Lamp History

Copies of "Incandescent Electric Lamps," issued by the Tariff Commission (ELECTRICAL WORLD, November 18, page 64), can be obtained from the Superintendent of Documents, Washington, D. C., at 25 cents a copy.

Stocks Turn Downward; Bonds Hold Ground


PRICE TRENDS OF ELECTRIC UTILITY SECURITIES
50 Bonds
36 Common Stocks
36 Common Stocks
50 Bonds
1931 1932 1933 1934 1935 1936 1937 1938 J F M A M J July Aug. Sept. Oct. Nov. Dec. 1939

Operating within a narrow range, electric light and power stocks yielded some ground this week. "Electrical World" index, 31.7; last week, 31.9, and last year, 28.6. Bonds held the gains of recent weeks, "Electrical World" index remaining unchanged at 106.1.

Two Colorado Issues Placed on Market

Offering was made to the public this week of $40,000,000 of first mortgage 3½ per cent bonds and $12,500,000 of 4 per cent debentures of the Public Service Co. of Colorado. The 3½ per cent bonds, due on December 1, 1964, will be priced at 102 and accrued interest and the 4 per cent debentures, due on December 1, 1949, also will be offered at 102 and accrued interest.

These two issues will constitute the only funded debt of the system.

Net proceeds from the sale of these issues and of $2,190,000 par value of common stock are to be applied to the retirement of various issues of funded debt of the company, outstanding on September 30 last in the amount of $43,671,800 and bearing interest from 5 to 6 per cent; to the payment of the company's secured note, due August 20, 1941, aggregating $4,500,000; to the payment of $2,190,000 of 6 per cent notes payable to Cities Service Power & Light Co., and other corporate purposes, including the payment of equipment obligations.

Both issues went to a premium after public offering.

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Shawinigan to Sell Notes

Shawinigan Water & Power Co. has applied to the Provincial Electricity Board of Quebec for authority to create and issue publicly $6,000,000 of 3½ per cent seven-year convertible secured notes, payable in Canadian funds. Proceeds will be used for reimbursement of expenditures already made and for the company's general capital requirements. The notes will be convertible into common stock at $25 a share during the first two years and $30 a share during the second two years.

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Preferred Dividend Arrears Paid Off

Several electric light and power companies have declared dividends in arrears on preferred stocks.

American Power & Light Co. announced dividends of $1.80 on the $6 preferred stock and $1.50 on the $5 preferred stock, both payable on December 20. This brings accumulated payments on the $6 issue to $4.80, against $3 in 1938, and to $3.62½ on the $5 stock, compared with $2.50 in 1938. Dividends of $1.12½ to holders of the $6 preferred and 93¾ cents to holders of the $5 preferred stock also were voted, both payable on January 2. Previously this year dividends of 75 cents each were paid on the $6 stock in January, April, July and October and 62½ cents was distributed in the same months on the $5 preferred issue.

Northwestern Electric Co., Portland, Ore., subsidiary of American Power & Light Co., has declared dividends of $21.87 on the 7 per cent preferred stock and $42 on the 6 per cent preferred stock, clearing up arrears on both issues.

Directors of Arkansas Power & Light Co. have voted to clear up all dividends in arrears—the equivalent of four quarters—on both the $7 and $6 preferred stock.

Iowa Southern Utilities Co. of Delaware has declared a payment on account of the dividend arrears on the former cumulative preferred stock of the company outstanding on August 3, 1938, at the rate of $1.75 per share for the 7 per cent series, $1.62½ per share for the 6½ per cent series and $1.50 per share for the 6 per cent series, payable on December 15 to holders of record on November 30 of dividend arrears certificates.

Michigan Gas & Electric Co. ordered dividends of $1.75 against accumulations on the 7 per cent prior lien stock and $1.50 a share on the $6 prior lien stock. Including these dividends, payments for 1939 will amount to $8.75 on the 7 per cent issue, against $4.37½ in 1938, and to $7.50 on the $6 stock against $3.75 last year.

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Associated Unit Seeks RFC Loan

In an effort to meet pending maturities of certain obligations, pay the balance of back taxes due to the federal government and obtain funds for new construction, Associated Gas & Electric Co. system, through its subsidiary, the NY PA NJ Utilities Co., has filed with the SEC an application seeking approval of a $26,500,000 loan which it expects to receive in part from the Reconstruction Finance Corporation.

NY PA NJ proposes to issue $26,500,000 in the form of promissory notes, secured by collateral, maturing in not less than five years and bearing interest at about 4 per cent. It is proposed to sell the notes not only to the RFC but also to such other participants as either the company or the RFC may procure.

The company has outstanding $8,500,000 of 8 per cent bonds due on March 15, 1940, of which $6,053,000 principal amount is in the hands of the public, the balance being held within the Associated System. The company owes the government $3,245,000 in taxes under a tax settlement recently reached.

As to construction, the company plans to improve plant facilities, extend transmission lines and rehabilitate distribution systems and about $12,000,000 of the proposed loan would go for these purposes.

Utility Reports

	Net Income 1939	1938
*Associated Electric and subs.	$2,322,059	$1,696,770
†Central Maine Pwr.	1,978,015	1,724,369
†Connecticut Lt. & Pwr.	4,170,059	3,843,401
†Detroit Edison	9,986,091	6,970,851
*Electric Power & Light and subs.	4,121,683	5,084,387
†Houston Lighting & Pwr.	2,501,663	2,631,184
†National Power & Light	7,498,074	8,582,596
*Pacific Gas & Electric	25,633,593	22,879,666
†Public Service of N. J. and subs.	26,039,549	22,335,103
*Standard Gas & Electric and subs.	‡3,465,911	‡1,462,651
†Texas Power & Light	1,376,290	1,165,809

*Twelve months ended September 30.
†Twelve months ended October 31.
‡Includes approximately $724,000 for 1939 and $461,000 for 1938 of undistributed earnings of a subsidiary company, which amounts are not available for distribution to Standard Gas due to state regulation requiring such subsidiary to maintain surplus equal to annual dividends on its preferred stock.

OPERATING PRACTICES

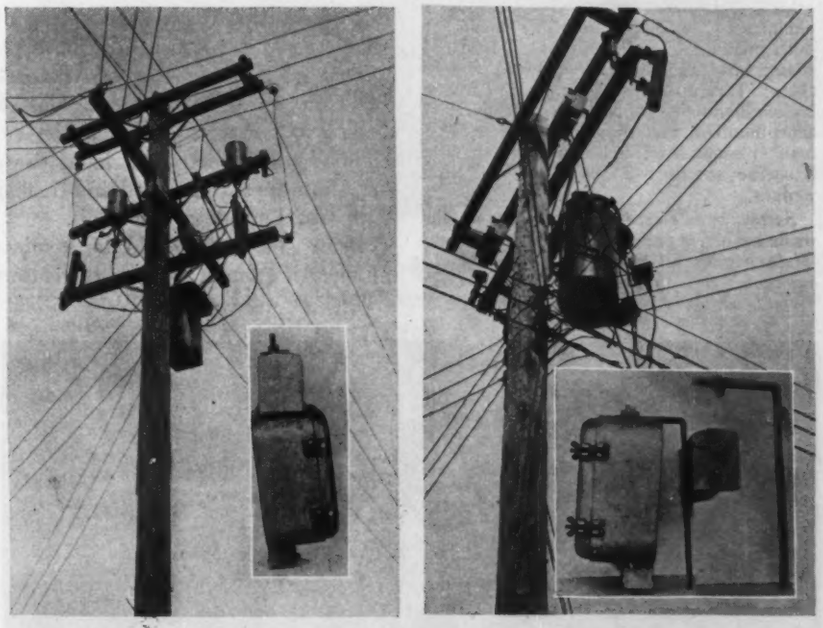
Graphic-Type Demand Meter Installation

By R. L. HAASE
Detroit Edison Company

For a number of years it has been common practice of the overhead lines department of the Detroit Edison Company to install graphic-type demand meters on distribution transformers when special load checks are desired.

When graphic type Lincoln demand meters were used with the single-ratio type current transformer most of the time required to make these installations was spent getting the current transformers installed. Use of the split-core type current transformer on the Maximeters has made it possible to cut the installation time in half. Four or five installations per crew day were made with the single-ratio type current transformers, whereas eight or ten installations are now made with the split-core type.

The problem of fastening the Lincoln demand meters to a pole or crossarm has been simplified by using an angle bracket made from strap iron. This bracket is usually made from scrap material $\frac{1}{4}$ x $1\frac{3}{8}$ in., cut 17 in. long. The angle, made about 5 in. from one end of the strap, is somewhat greater than 90 deg., so that the demand meter will be held at an angle slightly off the vertical position. It is quite important that the meter be held in this position so that the weight of the inking pen will tend to hold it firmly against the chart paper. If the meter is mounted in a vertical position a slight movement of the pole caused by the wind will allow the pen to swing away from the chart paper and a poor chart will result. Three 9/16-in. holes are drilled in the long leg of the bracket. A small lag screw is used to fasten the bracket to a pole or crossarm. The three holes allow some vertical adjustments for clearance between the meter case and line conductors when the brackets are attached to crossarms.



Split-core type current transformer halves installation time for load checks

Four or five installations per crew day on distribution transformers were made with single-ratio type current transformers (left), while eight to ten are now made with split-core type on Maximeter (right). Respective methods of fastening demand meters to crossarms are indicated in insets.

Another Mounting Method

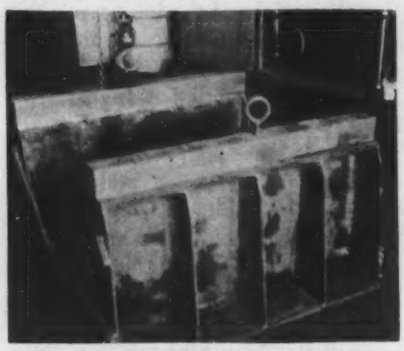
An alternate method of attaching these demand meters to crossarms is also shown. A bolt long enough to reach down through the crossarm is passed through a vacant pinhole and attached to the meter case. A small plate washer is used to prevent this bolt from falling through the pinhole. A pin nail, or some other small object, is placed between the bottom side of the crossarm and the meter case, so that the meter will be held in an inclined position which allows the inking pen to rest firmly against the chart paper. Experience has shown that good charts are obtained when the demand meters are mounted in this slightly inclined position.

To absorb some of the bumps in transporting meters of this type in the field it was necessary to provide a suitable cushion in the bed of the truck. Several layers of cardboard, taken from broken packing cases placed in the bed of the truck and covered with a tarpaulin, provide a very good cushion for this purpose.

Align Feed Pumps in Machine Shop

Boiler feed pumps at the Port Washington plant of the Wisconsin Electric Power Company are no longer torn down, repaired, reassembled and aligned at their operating locations in the plant. All these operations are now performed in the machine shop. An artificial foundation of welded boiler plate is used to mount the boiler feed pumps in the shop. This mount or jig is fitted with special steel mounting rails and machined level and to the exact dimensions of the pump's foundation in the plant.

Pumps transferred to this jig from their foundations are moved to the machine shop by cranes, measurements taken from the rails of the mount as data and the machine torn down. Reassembled and aligned to the original dimensions on the mount, the pump can be returned to its foundation in the plant, lined up with its drive coupling and put back into service without further adjustment.



Line up pump shaft in machine shop on jig that duplicates foundation

•

Transmission Line Maintenance Tools

Equipment carried by the Public Service Electric & Gas Company (N. J.) on its maintenance trucks for steel tower lines falls into four classes, as follows:

Line Tools and Equipment—Two bolt bags; 7 wrench belts; 5 body and safety belts; 12 assorted drill bits; 4 14-in. aluminum (static) blocks; 1 set of two-sheave blocks for ¾-in rope; 3 14-in. aluminum (conductor) blocks; 2 6-in. steel snatch blocks; 2 three-sheave blocks for ½-in. rope; 6 wood blocks for ½-in. rope; 1 lineman's safety chair; 3 dead-end chains; 12 assorted comealongs; 5 chisels; 1 bolt cutter; 2 Klein grips; 6 No. 2 ball peen hammers; 1 No. 3 ball peen hammer; 2 hacksaw frames; 12 hacksaw blades; 3 Coffing ratchet hoists; 2 insulator tool sets; 2 12-ft. hook ladders; 6 ½-in. hand lines; 2 16-ft. hook ladders; 3 ¾-in. guy lines; 12 nicking tools; 2 "old man" and ratchet; 16 assorted drift pins; 1 "C" punch; 5 Klein pliers; 4 ¾-in. reamers; 4 ⅝-in. reamers; 8 assorted sockets for ratchet wrenches; 12 ½-in. steel cable slings; 2 tail lines for ladders; 30 ratchet wrenches for Stockbridge dampers; 6 ratchet wrenches; 5 12-in. Crescent wrenches.

Miscellaneous Tools and Equipment—Three axes; 1 ½-in. wood bit; 1 ¾-in. wood bit; 7 pinch bars; 2 wrecking bars; 3 crow bars; 1 4-in. paint brush; 4 wire brushes; 7 pairs of boots; 1 set of fence blocks; 1 5-gal. can; 1 2-gal. can; 1 3-gal. water can; 3 pole chains; 6 sheets of emery cloth; 2 rolls of friction tape; 1 pitch fork; 4 Bulldog grips; 2 Buffalo grips; 2 Chicago grips; 2 8-lb. sledge-hammers; 2 pairs of climbing hooks; 6 bush hooks; 1 30-in. carpenter level; 1 string level; 1 pick and handle; 3 6-ft. rules; 4 raincoats; 4 8-in. screwdrivers; 1 long-handled, round-pointed shovel; 1 short-handled, round-pointed shovel; 1 2-man crosscut saw; 1 1-man crosscut saw; 5 scythe snathes; 2 50-ft. tapes; 3 iron wedges.

Safety and First Aid Equipment—One wash basin; 6 pairs of goggles; 1 ground set for truck; 1 Glowtector set; 1 first aid emergency kit; 5 snake-bite kits; 1 neon tube tester; 1 extra neon tube; 3 pairs of leather puttees; 1 cake laundry soap; 6 ground sticks; 3 ground stick extensions.

Material for Replacement or Repairs (varies according to the work to be done)—100-ft. aluminum repair tape; 70 assorted tower bolts; 20 step bolts; 140 assorted cotter keys; 24 assorted Crosby clips; 12 assorted parallel-groove clamps; 30 assorted clevises; 3 ½-in. "figure eights"; 12 assorted compression repair sleeves.

Electric Truck Supplements Crane

Seen more frequently in industrial plants, the electric truck can also find useful application in utility work. At the general service buildings of the Boston Edison Company a 5-ton electric crane is used for transferring a variety of heavy apparatus and material between locations and a 2-ton industrial type electric truck is a handy supplement to it inside the plant and around the yard for diverse jobs. In this view three 100-kva. transformers are being handled by the crane and the truck prior to testing these units in the maintenance shop. These devices greatly expedite equipment handling in comparison with hand methods and speed up repair work, testing and deliveries of apparatus to trucks for transport to points on the system.

•

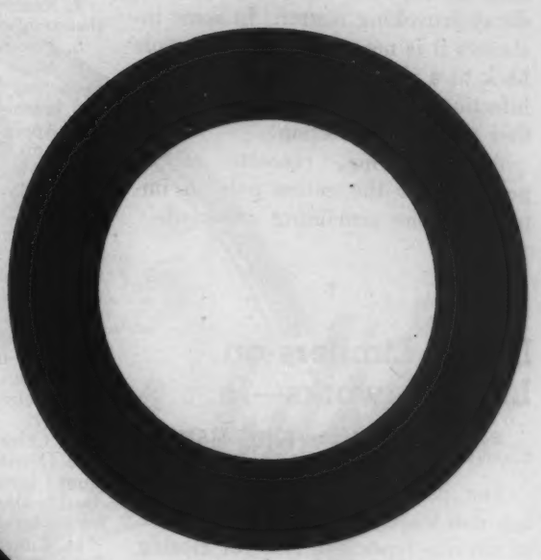
Cedar Poles Reclaimed at Low Cost

An average of 1¾ man-hours is required to complete the reclaiming of usable cedar poles that have been removed from service in the Arkansas Division of the Oklahoma Gas & Electric Company. Poles to be reclaimed are shaved with hand draw knives in the storage yard and treated with No. 1 grade creosote oil.

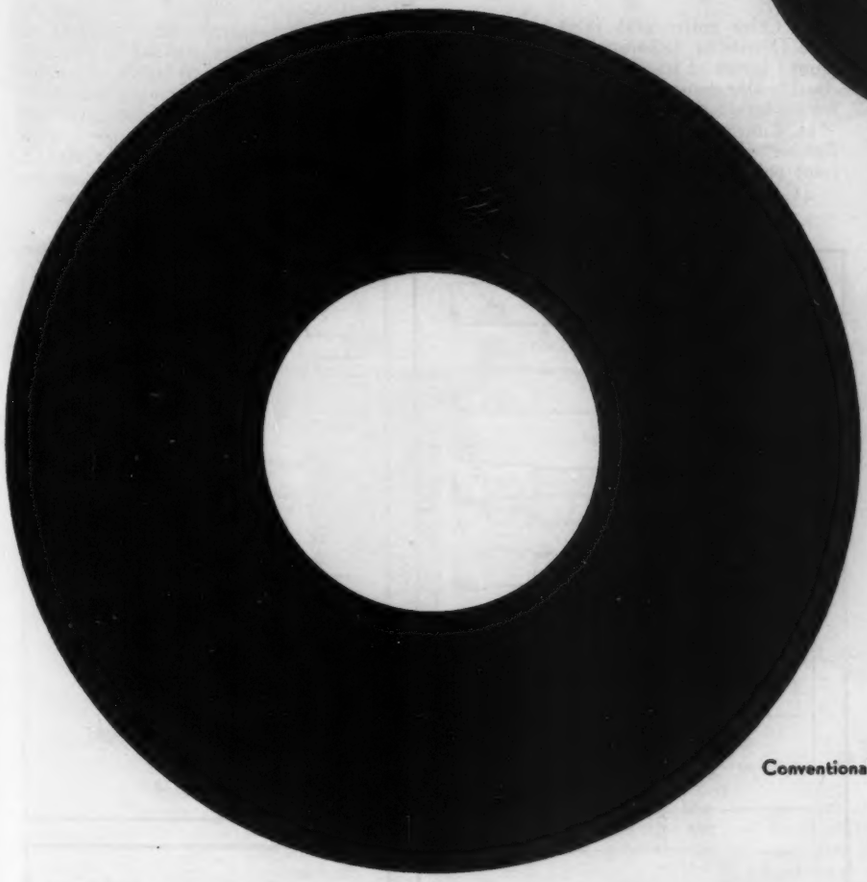
Draw shaving is held to a minimum. An attempt is made to remove

Corrugated drip pans recover creosote used in reclaiming hand-shaved poles

Simplex-LATOX
Small Diameter
Rubber Insulated Wire



Latox Insulation



Conventional Insulation

Both white circles are the same size, inspite of what your eyes tell you and represent size No. 14 conductors. The black rings represent LATOX and ordinary insulation for the same service. (enlarged 30 times.)

The illustrations show the relative diameter of Simplex-LATOX insulated conductors and ordinary rubber insulated conductors. It shows why you can put more LATOX conductors in a conduit or cable.

Simplex-LATOX is 90% rubber. With its high quality it can be thin and still deliver better service than heavier, bulkier conventional insulation.

Simplex Wire & Cable Co., 79 Sidney Street, Cambridge, Mass.

Simplex – LATOX

Thin insulation made directly from rubber latex

only the sapwood rot and any other decay-provoking matter. In some instances it is necessary to cut the pole back to a shorter length to eliminate infection and the possibility of further source of infection.

After shaving, creosote oil is poured over the entire pole to impregnate the remaining sapwood.

•

Install Limiters on L.-V. Networks—II

By C. P. XENIS and E. WILLIAMS
Consolidated Edison Company of New York, Inc.

The detailed method of connecting non-leaded cables to crab joints of various types and also for closing the unused crab joint terminals by means of terminal caps is shown by the accompanying illustrations. Note the roll-back feature incorporated in the non-fusible crab joints; its use wherever possible reduces the amount of taping necessary in making connections (See ELECTRICAL WORLD, October 7, 1939, page 72). The procedures follow:

(A) Non-fusible crab joint installation:

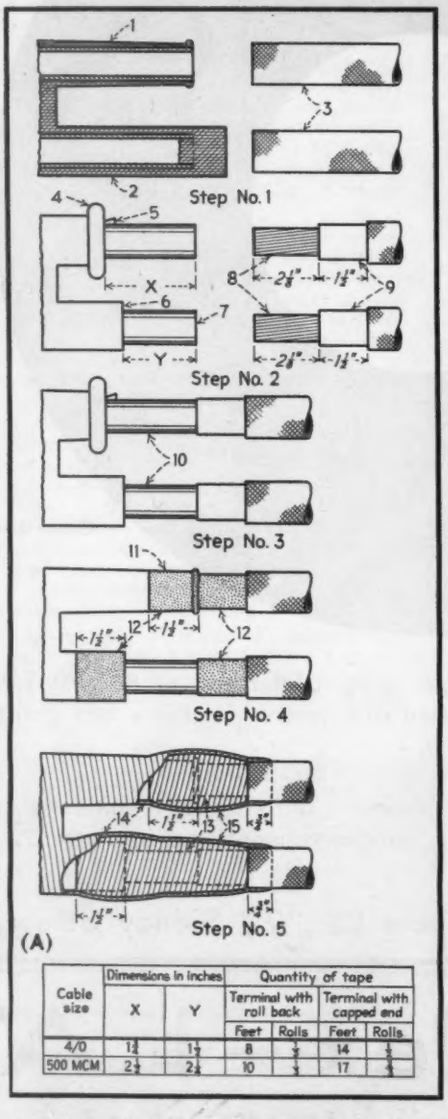
1. Non-fusible crab joint terminal with rubber insulation having roll-back feature.
2. Non-fusible crab joint terminal with rubber insulation having capped end.
3. Non-leaded cable.
4. Roll-back rubber insulation to expose tubular copper terminal of crab joint.
5. Install rubber wedge to hold rolled-back rubber insulation in position.
6. Cut back rubber insulation on capped terminal to expose tubular copper terminal.
7. Remove all traces of rubber insulation from inside and outside of tubular copper terminal.
8. Remove insulation and clean strands thoroughly.
9. Remove all braids and tapes.
10. Make compression joint with press; make one indentation for No. 4/0 cable; make two indentations for 500,000-circ.mil cable.
11. Unroll rubber insulation.
12. Roughen rubber insulation with abrasive cloth. Apply thin even coat of rim cement. Brush off excess cement and allow to dry one minute before applying tape.
13. Apply Kerite tape or Uskorona tape half-lapped with sufficient tension to reduce its width from ¾ to ½ in. (See table for amount of tape required.)
14. Cover entire crab joint and rubber tape (Kerite or Uskorona) with two half-lapped layers of friction tape applied with considerable tension in order to compress under layers of rubber tape.
15. Finish by applying one coat of U.S. Rubber Products Co. rubber expansion joint paint or equal over friction tape.

(B) Fusible crab joint installation:

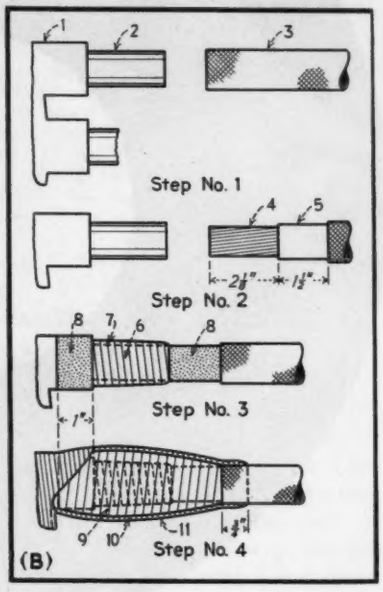
1. Fusible crab joint rubber insulation.
2. Fusible crab joint tubular copper terminal.
3. Non-leaded cable.
4. Remove insulation and clean strands thoroughly.
5. Remove all braids and tapes.
6. Make compression joint with press; make one indentation for No. 4/0 cable; two indentations for 500,000-circ.mil cable.
7. Apply ¾-in. asbestos tape half-lapped. Build up flush with surface of crab joint shell. Woven asbestos sleeve or sheet may be used instead of tape if more convenient.
8. Roughen rubber insulation with abrasive cloth. Apply thin, even coat of rim cement. Brush off excess cement and allow to dry one minute before applying tape.
9. Apply Kerite or Uskorona tape half lapped with sufficient tension to reduce its width from ¾ to ½ in. For No. 4/0 cable use 16 ft. (approx. ½ roll); for 500,000-circ.mil cable use 20 ft. (approx. ¾ roll).
10. Cover entire crab joint and rubber tape (Kerite or Uskorona) with two half-lapped layers of friction tape applied with considerable tension in order to compress the under layers of rubber tape.
11. Finish by applying one coat of U.S. Rubber Products Co. rubber expansion joint paint or equal over friction tape.

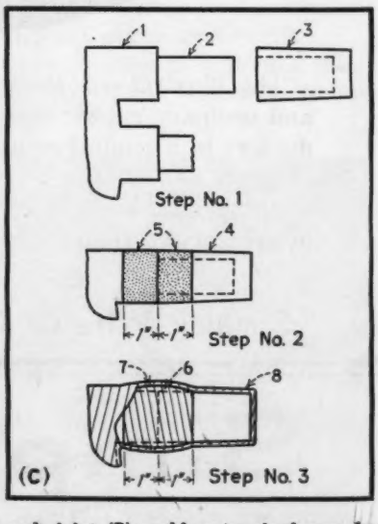
(C) Method of installing rubber terminal cap on unused crab joint terminals:

1. Crab joint rubber insulation.
2. Unused crab joint terminal (tubular or cable).
3. Rubber terminal cap.
4. Slide rubber terminal cap over unused crab joint terminal.
5. Roughen rubber insulation with abrasive cloth. Apply thin, even coat of rim cement. Brush off excess cement and allow to dry one minute before applying tape.
6. Apply Kerite or Uskorona tape half lapped with sufficient tension to reduce its width from ¾ to ½ in. For capping No. 4/0 tubular terminal use 7 ft. (approx. ¼ roll); for 500,000-circ.mil tubular terminal use 9 ft. (approx. ⅓ roll); for 500,000-circ.mil cable terminal use 6 ft. (approx. ¼ roll).
7. Cover entire crab joint, rubber tape (Kerite or Uskorona) and rubber terminal cap with two half-lapped layers of friction tape applied with considerable tension in order to compress the under layers of rubber tape.
8. Finish by applying one coat of U.S. Rubber Products Co. rubber expansion joint paint or equal over friction tape.

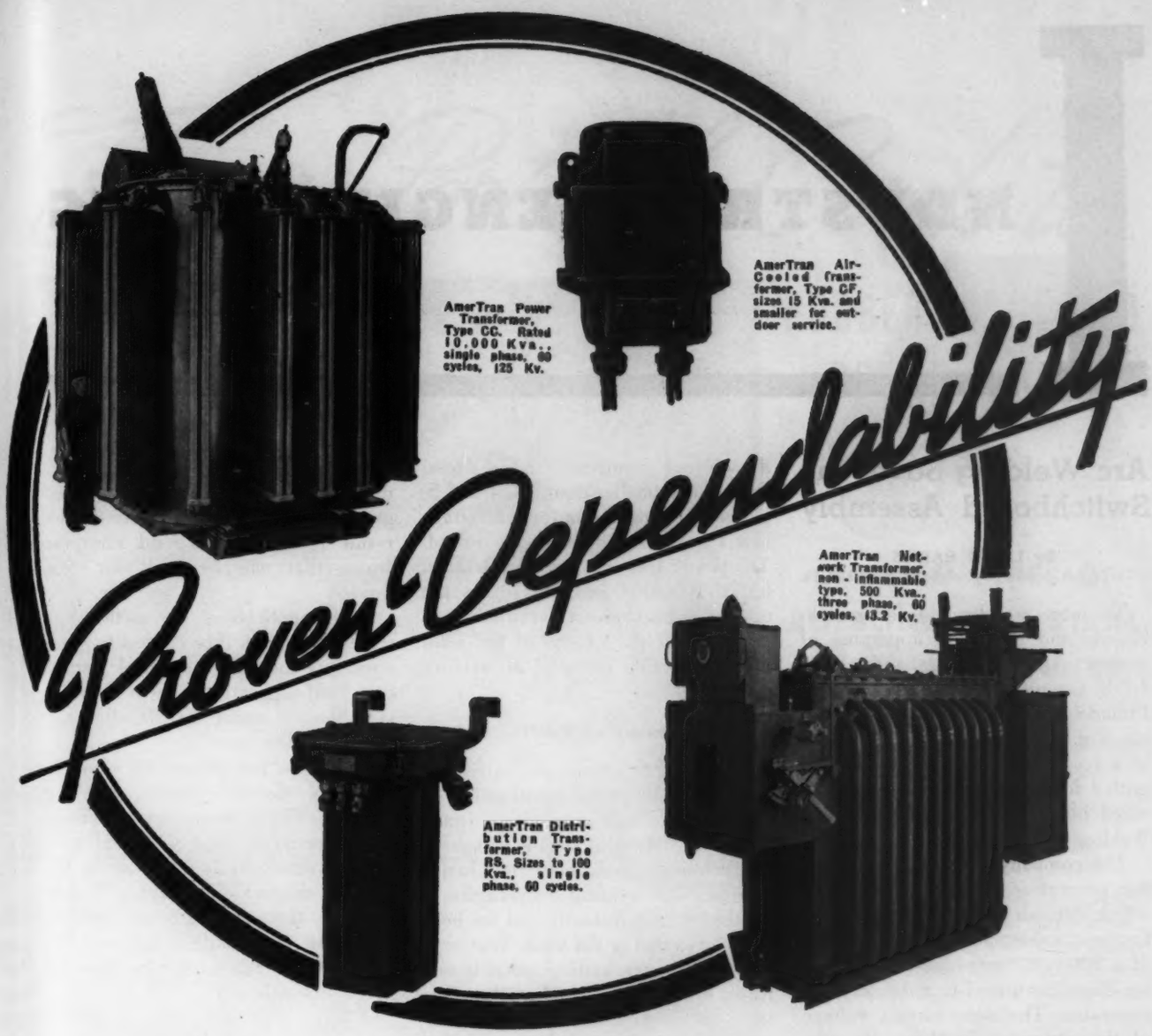


Cable size	Dimensions in inches		Quantity of tape			
	X	Y	Terminal with roll back		Terminal with capped end	
			Feet	Rolls	Feet	Rolls
4/0	1½	1½	8	½	14	½
500 MCM	2½	2½	10	½	17	½





Fusible crab joint installation (A); non-fusible crab joint (B); rubber terminal cap for unused crab joint terminal (C)


AmerTran Power Transformer, Type CC. Rated 10,000 Kva., single phase, 60 cycles, 125 Kv.
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TRANSFORMERS

INDUSTRIAL ENGINEERING

Arc Welding Saves in Switchboard Assembly

By LLOYD HAINES
I-T-E Circuit Breaker Company, Philadelphia, Pa.

To meet the demand for switchboards and switching apparatus of greater capacity and reliability, the I-T-E Circuit Breaker Company of Philadelphia is welding joints instead of bolting them. This was stated in a recent paper by the writer submitted for the award program sponsored by the James F. Lincoln Arc Welding Foundation.

The company has seven arc-welding generators of the portable type which furnish welding currents for fourteen welders. Each unit consists of a 220-volt, two-phase electric motor direct connected to a d.c. welding generator. The open circuit voltage of the generator is about 50 volts and the welding current is approximately 100 amp. at 25 volts, or about 1½ kw. welding load.

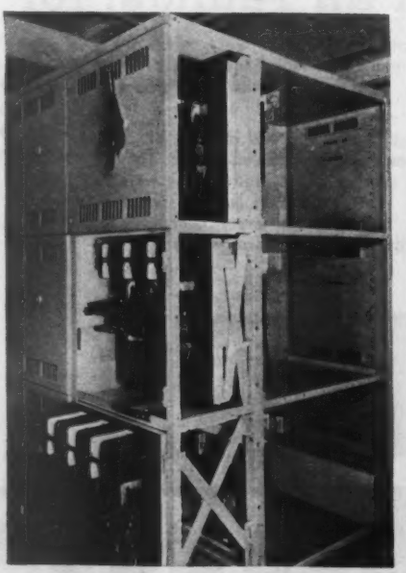
Leads from an arc-welding generator to the work should be as short as possible to reduce electrical losses; however, it is possible to do small emergency welding jobs at some distance from a welding generator. For instance, by installing permanent wiring from a welding department through an erecting shop, a one-way distance of 200 ft. with copper terminal blocks located every 25 ft. on columns in the erecting shop, a welder may attach his welding leads to the terminal blocks on the column and with a ⅛-in. electrode weld a bracket, conduit support strap or other accessory to a switchboard frame or other apparatus under construction without moving the portable welding generator to the vicinity of the work. The wire should have a flame-proof insulation and a cross-section not smaller than No. 4 B. & S. gauge. To compensate for the voltage loss the generator voltage is raised. The power loss may be considerable, but it is rather insignificant as the cost of electric power for welding is but a small percentage of the total of all the costs included in welding operations.

Economy of Welding

Arc welding plays an extremely important rôle in the construction of frames for high capacity circuit breakers. Structural steel is comparatively cheap and may be easily welded. The welding temperature is reached almost instantly and the heat is concentrated at the weld. Temperature of the surrounding metal is not raised excessively, which makes better working conditions and permits greater accuracy in construction. The various parts of the frame are welded directly together; no joint plates, greater accuracy in construction. The result is the neatest and cheapest frame that can be built for this service.

Other applications are in the construction of desk type control boards, open type switchboards, steel frames for self-supporting switchboards, switchboard meter panels, lighting panel cabinets, etc.

Total cost per minute of welding, including electric current, welding rods, interest on investment, depreciation per year, repairs, rental and welder's salary, is about 8.3 cents. Of the total the welder's salary is 80 per cent, so that the cost per minute would be more largely affected by variations in this one item than in any of the others.



Complete Multimite switchboard is made up by bolting a number of welded panel frames together

•

Automatic Control of Plant Capacitors

A simplified capacitor control installation which automatically switches three banks of capacitors totaling 975 kva. in and out of the circuit as changing load conditions require is saving an Eastern manufacturing plant approximately $1,000 a month.

Previously, the plant generated its own energy; the utility company provided that, if the plant should raise its power factor from approximately 60 to 90 per cent, it would supply the energy at a cost lower than that of the steam generator. The plant consists of a group of large, long and narrow buildings. In some of the buildings the I^2R loss was reclaimed by capacitor units installed at the larger motors or at the feeder ends.

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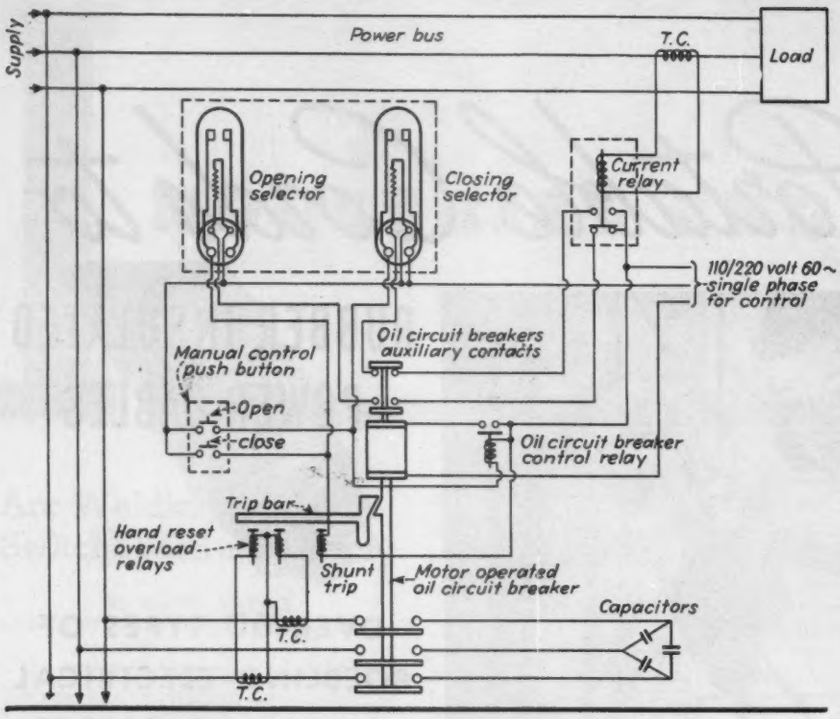
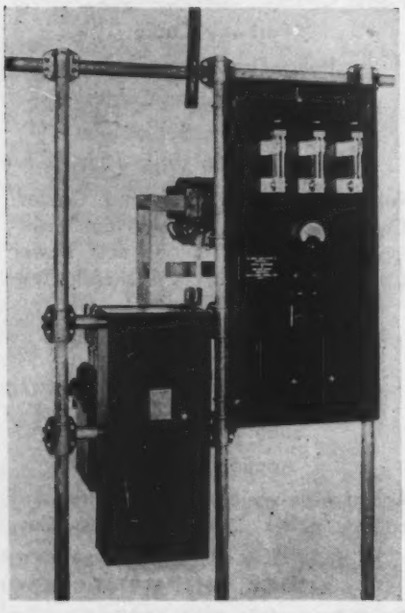


Power factor control panel switches capacitors in and out of plant system as needed



Control equipment (left) includes over- and under-current and thermal relays actuating motor-operated circuit breaker to connected and disconnect associated capacitor bank. Diagram (above) indicates connections.

In all, 1,480 kva. of capacitors, ranging from 6 to 10 kva. each, for operation on 460 volts, three phase, 60 cycles, are used in this manner; each unit is protected by a safety fused switch.

At other locations, where wide variations in load conditions occur, automatic control was provided for the capacitor installations, consisting of one frame of 465 kva. and two frames of 255 kva. each, all for operation on 460 volts, three phase, 60 cycles. Each frame is controlled by a power-factor control panel, which includes an over- and an under-current relay together with a thermal relay to prevent any momentary surges from operating the relay.

Delayed Operation

At these locations, when the load rises to the over-current relay setting and is maintained for two minutes, the thermal relay closes the associated circuit breaker, electrically operated, connecting in the capacitors. This thermal relay also guards against pumping any surges from the line into the capacitors or from the capacitors back to the under-current relay. When the load falls to the under-current setting and is maintained for two minutes, this operation is reversed and the capacitors are disconnected. Thus the capacitors are "floated" in and out of the circuit as load condititons require.

The capacitor installation of 465 kva. includes 120 kva. permanently connected in the system, controlled by a hand-operated circuit breaker, and 345 kva. "floated" in and out and controlled by a motor-operated breaker as described above.

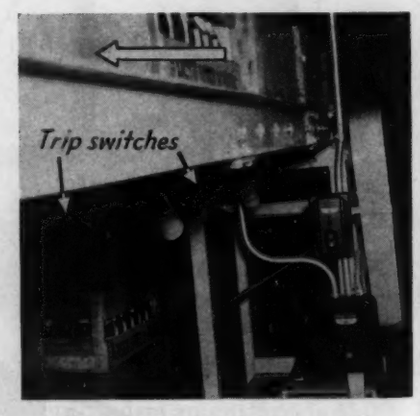
Capacitors and control panel were installed by United Electric Controls Corporation, New York, N. Y.

•

Trip Switches Control Automatic Conveyor

Continuous automatic delivery of bottles to the motor-driven washer at the new south side plant No. 2 of the Pepsi-Cola Bottling Company, Chicago, depends upon a trip-switch-operated fully automatic inclined conveyor belt which lifts the cases of "empties" from the low point of a gravity roller conveyor to a second roller conveyor on which they pass by gravity to the washer.

Two trip switches spaced slightly more than a case length apart are connected in parallel and arranged so that when a case passes over the pivoted and counter-weighted sections of the conveyor the switches are tripped to the "off" position. Since the switches are in parallel the conveyor drive motor is de-energized only when both limit switches are tripped and held off at the same time. This occurs only when the roller conveyor is filled with cases from the



Limit switch control makes conveyor fully automatic

inclined belt conveyor up to the washer. When this happens cases are end to end and both pivoted sections of the roller conveyor are down, holding the limit switches in the off position. As long as the cases pass over the pivoted sections continuously the switches are tripped consecutively and the conveyor motor continues to operate.

SELECT G-E HIGH QUALITY BUILDING WIRE

GENERAL ELECTRIC...12 R 600 V...CODE GRADE
ELECTRIC...12 RP 600 V...PERFORMANCE GRAD
CTRIC...12 RH 600 V...HEAT RESISTANT GRA
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Four standard grades of G-E Building Wire are available—every one a leader in its class. All G-E Building Wires surpass Underwriters' requirements. Research goes on endlessly. Only the finest of raw materials are used. Manufacturing is done according to rigid specifications. Quality is uniformly high.

The insulations on G-E Wires determining the grade follow:

G-E Code Grade—Compound exceeds Underwriters' requirements

G-E Performance Grade—Compound contains not less than 30 per cent new rubber

G-E Heat Resistant Grade—Super aging compound, conforms to Federal Specifications JC 106

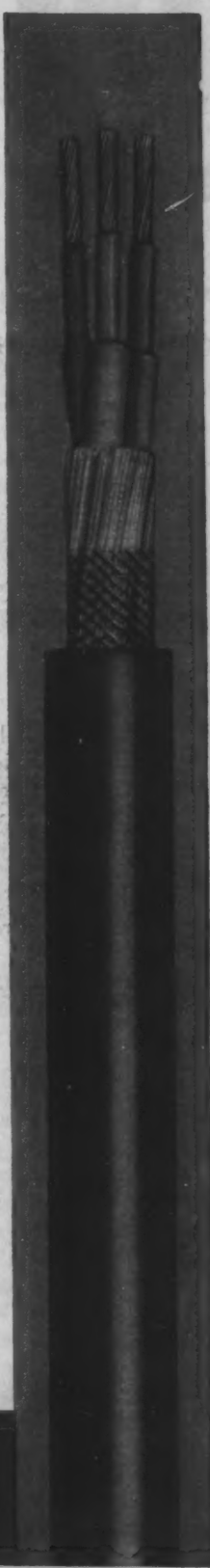
G-E Moisture Resistant Grade—Compound has low moisture absorption rate enabling wire to be used in lieu of leaded cable. Reference Article 300, Section 3035, N.E.C.

G-E Building Wire is marked for quick identification of insulation, size, type and voltage. It is easy stripping, clean stripping and easy pulling. Generous coatings of paraffin help to make handling easy.

G-E ALL-RUBBER CORDS FOR EVERY PURPOSE

The G-E line of all-rubber cords is complete—starting with CORDX, 60 per cent Type S All-rubber Cord, for use where conditions are most severe ranging down to PO-SJ Special lamp cord. You are sure to find exactly the cord you need. These cords are attractive in appearance, dependable and long-lived.

For further information see the nearest G-E Merchandise Distributor or write to Section W-91112, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.



GENERAL ELECTRIC

NEW ENGINEERING IDEAS

Polar Integrator for Plane Surfaces

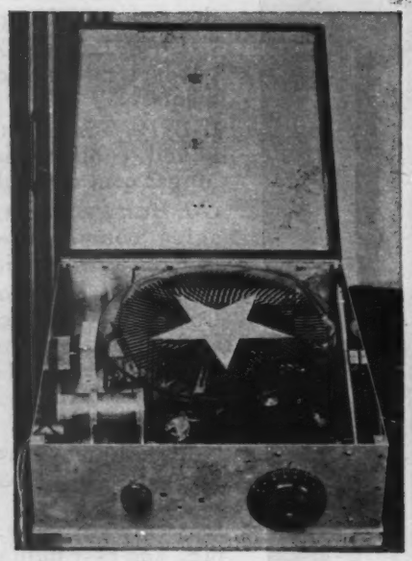
For increased accuracy and convenience in measuring the areas of plane irregular surfaces the Stockton Profile Gauge Corporation, Lowell, Mass., has recently developed a polar integrator which combines light source, reflector and photocell in a compact cabinet.

Above a light source and at right angles to the beam is a rotating disk of transparent material, preferably glass. Concentric circles of this disk are marked off into alternate opaque and transparent sections, with each section calibrated to equal 0.1 sq.in. The shaft holding this disk is driven at a predetermined rate by a small motor.

When the cover of the cabinet is closed it serves as a reflector for the light beam, which is transmitted through the transparent section of the disk to a photocell mounted on the shaft below the disk and restrained by a coil spring. In the photocell circuit are a special amplifier and thyratron, together with a ratchet motor that operates a counter.

The plane surface to be measured is placed on the disk, the cabinet cover is shut and a switch to start the disk revolving is closed. After the disk has made one complete revolution the light source and the photocell recede one notch toward the center and the second concentric circle is scanned. This process is repeated until the whole disk has been scanned, except for a small portion of known area in the center.

In the model illustrated the known value of the disk is 100 sq.in. and the counter is calibrated accordingly. The counter is set at 100, therefore, and revolves backward. At the end of the measuring cycle it indicates the area of that portion of the disk covered by the surface being measured.



Polar integrator with operating mechanism exposed

When the measuring cycle has been completed the power is automatically shut off. The cover of the cabinet then can be lifted and another surface measured. Refinement in the opaque and transparent sections of the disk and in the light beam interrupted by these opaque sections permit increased accuracy.

Industrial applications include such work as the measurement of irregular patterns which are laid out on regular or irregular material. Thus sets of shoe patterns could be measured, laid out for cutting and the waste measured. By trial, it could then be determined which layout of the irregular surfaces would give the best results with a minimum waste of material.

New Starting Device for Fluorescents

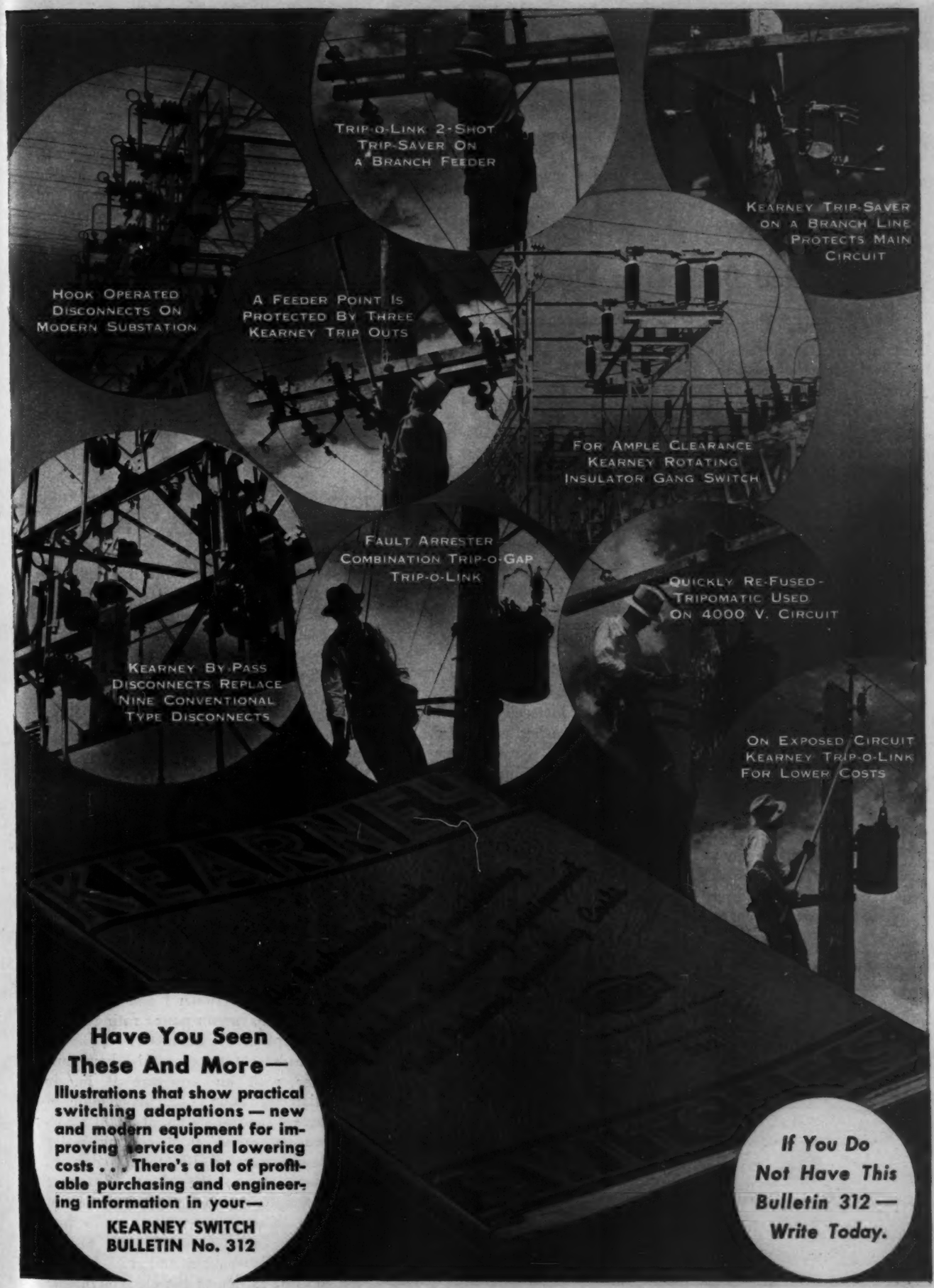
Use is made of the bi-metallic thermostat principle in a new fluorescent lamp-starting device, which was developed to overcome the inherent disadvantages of the more conventional thermal starting switch.

In fluorescent lamps, as in other gaseous discharge tubes, a momentary high-voltage "kick" is required to establish an arc between the electrodes at the opposite ends of the lamp; if the electrodes are preheated the arc will jump more quickly. Thermal relays, used as starting switches, were inaccessible, consumed current and stayed hot while the lamp was operating, hence they had to be allowed to cool before they would restart the lamp after a shutdown.

Heat Closes Contacts

Known as a "glow" switch, the new starting device is about 1 in. long and about $\frac{3}{8}$ in. in diameter and resembles a miniature electric lamp, but contains an easily ionized gas and two bi-metal electrodes which serve as the switch contacts. The switch is connected in parallel with the fluorescent lamp; when the current is turned on a glow discharge is created between the normally open switch contacts on the bi-metal electrodes. The heat of the glow causes the contacts to close. At this point the lamp electrodes are heated to a bright red color.

When the contacts close the glow discharge automatically ceases, allowing the bi-metal elements to cool and separate, opening the switch and striking the arc. The whole operation, from the time the current is applied


TRIP-O-LINK 2-SHOT TRIP-SAVER ON A BRANCH FEEDER
KEARNEY TRIP-SAVER ON A BRANCH LINE PROTECTS MAIN CIRCUIT
HOOK OPERATED DISCONNECTS ON MODERN SUBSTATION
A FEEDER POINT IS PROTECTED BY THREE KEARNEY TRIP OUTS
FOR AMPLE CLEARANCE KEARNEY ROTATING INSULATOR GANG SWITCH
FAULT ARRESTER COMBINATION TRIP-O-GAP TRIP-O-LINK
QUICKLY RE-FUSED-TRIPOMATIC USED ON 4000 V. CIRCUIT
KEARNEY BY-PASS DISCONNECTS REPLACE NINE CONVENTIONAL TYPE DISCONNECTS
ON EXPOSED CIRCUIT KEARNEY TRIP-O-LINK FOR LOWER COSTS

Have You Seen These And More—

Illustrations that show practical switching adaptations — new and modern equipment for improving service and lowering costs . . . There's a lot of profitable purchasing and engineering information in your—

KEARNEY SWITCH BULLETIN No. 312

If You Do Not Have This Bulletin 312 — Write Today.

MADE BY THE **JAMES R. KEARNEY CORPORATION** 4224-42 CLAYTON AVE. ST. LOUIS, MISSOURI

until the arc is established, requires only one or two seconds.

As used in the new Westinghouse fluorescent lamp starter, the glow switch and a tiny condenser to eliminate radio interference are housed in a small aluminum shell equipped with a bayonet-type end and inserted in a special socket attached to a standard fluorescent lampholder. Thus the starting unit is readily accessible and replaceable. Since it is now separate from the starting unit and need not be accessible after installation, the choke or ballast device (necessary to limit the operating current) is made more compact and may be mounted in any convenient place.

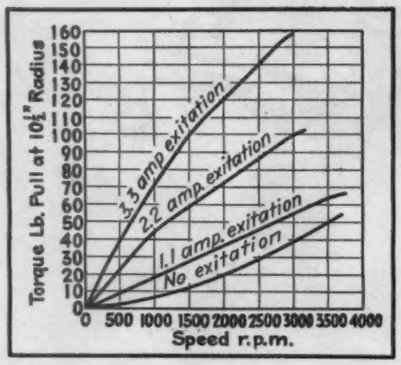
• • •

Water-Cooled Design for Electro-Dynamometer

By ERNEST BERNARD
Chicago, Ill.

Novel feature of an electrodynamic absorption dynamometer developed by the author is that power developed by the prime mover under test is absorbed in large part by generation of current that is dissipated as heat within a high-resistance squirrel-cage armature rotating in water. The water serves the double purpose of cooling the rotor and absorbing some of the mechanical energy delivered to it.

The dynamometer consists essentially of two elements, the stator or field magnet frame and the rotor or armature. The stator has the same conventional principle of mechanical and electrical construction as the stationary field magnet system of a direct-current or an alternating-current generator, with certain additions and modifications for application to absorption dynamometer construction. The field coils within a watertight housing in the field magnet frame are energized by a separate source of direct-current supply, the exciting current being regulated in the usual manner by a field rheostat. The rotor or armature is inclosed in a watertight housing or casing, with the cooling water circulated between the inlet and exhaust openings, providing a system for dissipating the power generated and absorbed in the armature.



Torque characteristics show portions of torque attributable to hydraulic and electrodynamic effects

Torque developed in operation of the dynamometer is measured by a scale- or weight-measuring device connected in the usual manner to one of the torque arms extending radially from the dynamometer pole yoke.

The armature consists of a laminated iron core arranged with water-circulating ducts and a high electrical resistance closed circuit armature winding formed by conductor bars in the armature slots, brazed or welded together at the portion extending beyond each end of the armature core, to form connecting end rings.

The high electrical resistance feature in the armature incorporates in the power-absorbing closed circuit the equivalent resistance value of an external power-absorbing load resistance connected to the conventional direct-current dynamometer or generator.

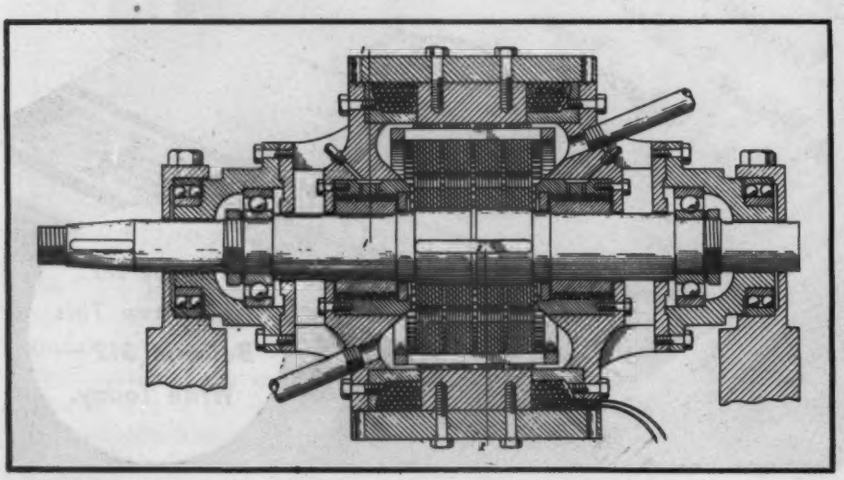
Wide Speed Range

Also the high electrical resistance armature winding enables the absorption dynamometer to develop useful and practical values of power and torque over a wide range of speed.

In operation of the dynamometer the cooling water circulates through the armature-circulating ducts at a rate proportional to the armature speed, while the same cooling water flows between the armature-casing inlet and exhaust openings at a rate to keep the dynamometer within operating temperatures. The temperature of the cooling water is controlled in the usual manner of a hydraulic absorption dynamometer, by valves placed in the inlet and exhaust pipe lines. The dynamometer may be operated over the complete power and speed range at any desired temperature up to 200 deg. F.

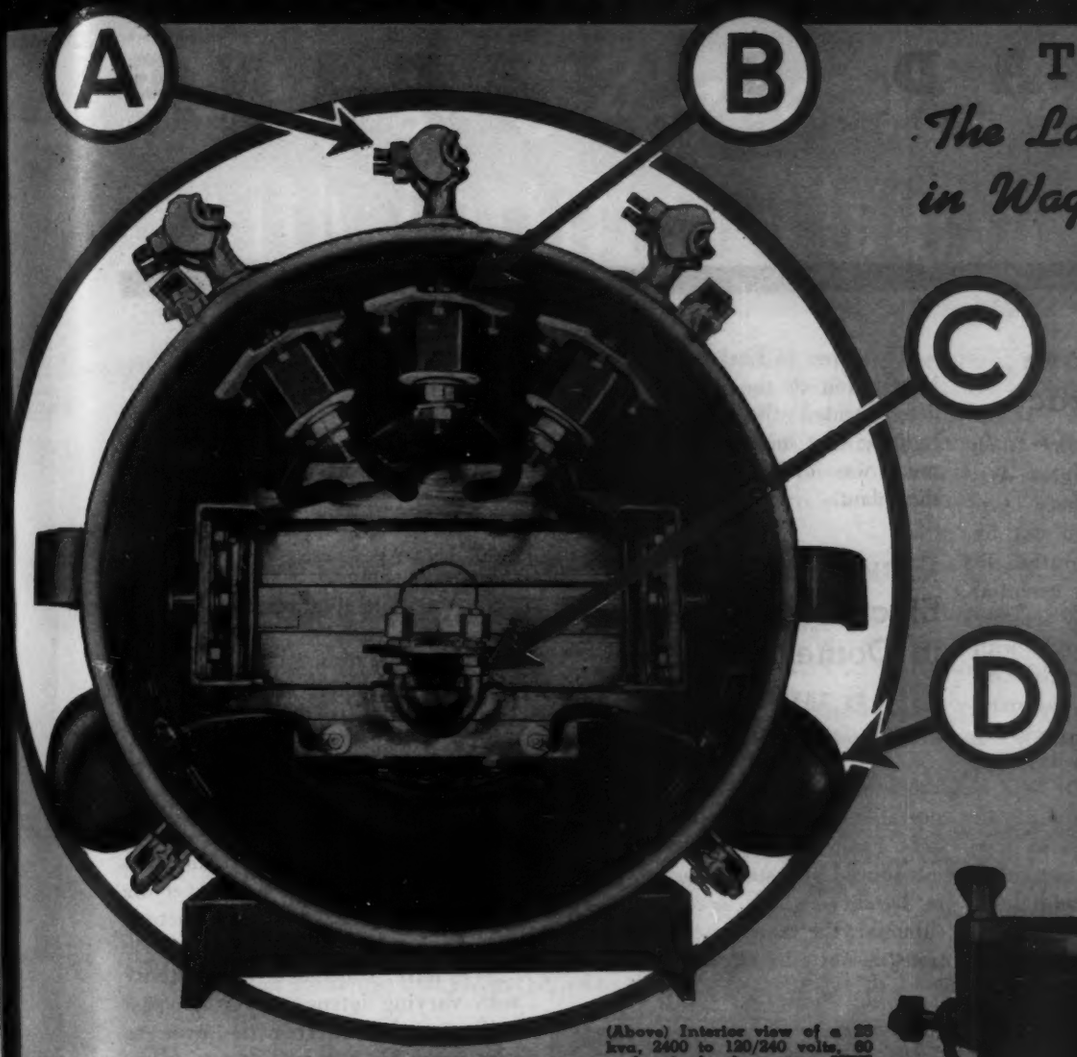
Load variation is obtained by adjusting its excitation field rheostat, the field excitation power consumption being between 1 and 2 per cent of the maximum power rating of the absorption dynamometer.

In recent tests of this dynamometer with an armature 9 in. in diameter and 4 in. net length of core a load of 79 hp. at 3,000 r.p.m. was absorbed at a cooling water temperature of 180 to 200 deg. F. Referring to the chart of torque characteristics of a total torque of 158 lb. at 3,000 r.p.m., or 79 hp., 38 lb., or 19 hp., is due to the hydraulic feature and 120 lb., or 60 hp., is due to the electrodynamic feature.



Electrodynamic absorption dynamometer has armature running in water for cooling

A NEW, MODERN Distribution Transformer



TYPE HEX

The Latest Development in Wagner Transformers

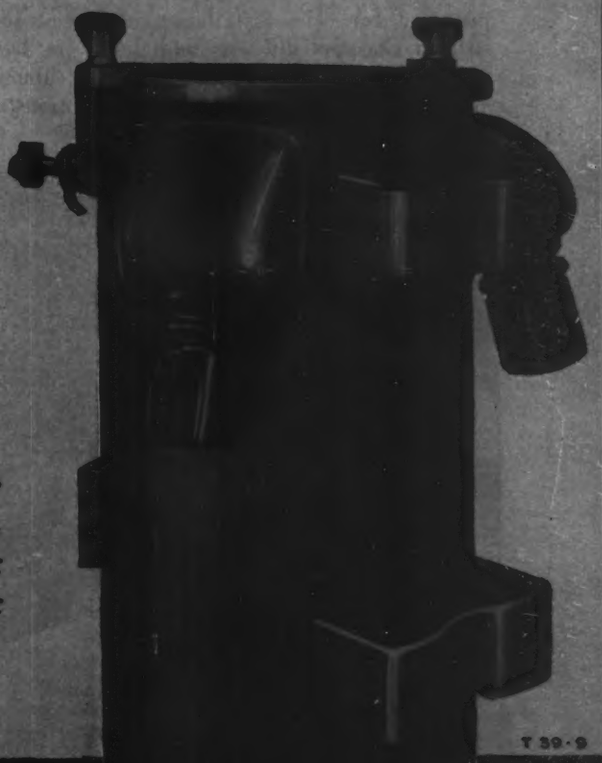
A Solderless connectors on all bushing terminals make installation easier. The insulation level of the bushings and windings are so coordinated as to cause abnormal line surges to flash over the bushings on the outside of the tank.

B Each bushing is of the removable type, held definitely and positively in place by means of a simple clamping ring assembly.

C Disc type interchanging device consists of taps terminating in studs fastened in a bakelite disc.

D The one-piece copper-bearing steel bushing pocket is securely welded to the tank wall giving it a streamlined appearance.

(Above) Interior view of a 25 kva, 2400 to 120/240 volts, 60 cycle, single-phase, type HEX distribution transformer.
(Below) A 3 kva showing the new pocket type primary bushings.



T 39-9

addition to the above features, this new Wagner distribution ansformer has many other advantages and like all Wagner ansformers it is designed to give high efficiency and depend-ble, uninterrupted service.

The line of Wagner transformers is complete and includes stud-shing type distribution transformers, sub-station transformers, ral-line transformers, air-cooled transformers and power ansformers. No matter what your requirements are Wagner ansformers will do the job.

Write for Complete Literature

Wagner Electric Corporation

400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

TRANSFORMERS • BRAKES • FANS • MOTORS

LOAD BUILDING

New Lights Improve Production Accuracy

Hydraulic equipment for such manufacturers as the Douglas Aircraft Company and Lockheed Aircraft Corporation is turned out by Herberts Engineering Corporation, in Vernon, Calif. Precision is essential to the plant's operation. By making it possible for workmen to see with less effort, Southern California Edison Co. lighting engineers improved the plant's speed and accuracy through installation of new lighting equipment in the shop room.

An average light intensity of 42 ft.-candles on working surfaces was provided for. The installation consists of Glassteel diffusers with 500-watt daylight lamps, mounted 10 ft. high on 10-ft. centers.

According to Earl H. Howard, the installation in the shop so forcibly demonstrated the value of better lighting that modern lighting equipment was ordered for the rest of the plant.

•

Electric Oven Good in Domestic Field

By TAYLOR C. HARVEY
Sales Manager
Public Service Company of New Hampshire, Manchester

We became interested in the small portable oven manufactured by Landers, Frary & Clark when it was first introduced and started our campaign in January, which, according to the calendar, the thermometer and traditions, is not a month in which to sell ovens. Our campaign was the usual three-part drive with:

1. Demonstrations by the salesmen and home service workers.
2. Advertising, direct by mail and newspaper.
3. Offering the ensemble of oven and table, on attractive terms.

We felt that customers would accept this portable oven because it looks like an oven, works like an oven, its operation is simple, requiring no particular mechanical ingenuity, and it is easy for the salesmen to demonstrate.

However, we underestimated the customers' desire to own such a piece of equipment and sales started being made almost immediately and, by May, we were selling ovens "over the counter" in a very satisfactory volume.

We have continued this activity with varying intensity over the past eight months, offering the oven to any one who cared to try it for a demonstration, and have discovered the following:

1. The portable oven is not class merchandise. It is acceptable in all types of homes—as an added oven in the all-electric kitchens; a convenient cooking device for the large farm home with a wood stove; in apartments, and in homes of the so-called "low-income" group.
2. The oven is also a splendid incubator for range sales. A good demonstration of an oven will sometimes sell a customer on the advantages of electric cooking who might otherwise remain skeptical for some time.
3. The oven should always be sold with a stand or table and located in a convenient place in the kitchen, because if it ever gets put away on a shelf or in the pantry, it soon becomes just another idle appliance.
4. In the so-called "low-income" group the kilowatt-hour increase is relatively small, but this increase does occur during the normal low consumption months, namely, in the summer. However, in the homes where electricity is used more generously, we find that the kilowatt-hour increase is greater, probably because these customers are more used to using electricity

Forty-two ft.-candles for working surface

Precision is of first importance in the operation of these machine tools in the Herberts Engineering Corporation plant at Vernon. Glassteel diffusers were used in the new lighting installation, which improved speed and accuracy.

New "Plus" Kilowatt Hours through *Fluorescent Lighting* with Certified Fleur-O-Liers

● Utility companies, in increasing numbers, are discovering a new "plus" in load building . . . MAZDA F Lamps with CERTIFIED FLEUR-O-LIERS. The use of CERTIFIED FLEUR-O-LIERS is your insurance of satisfactory service...because they have been *certified* on these important points: 1. Corrected to 85% power factor, or better; 2. Reduction of flicker—for close eye work; 3. Use of auxiliary equipment certified by E.T.L.; 4. Specifications as to light output, reduction of glare, electrical and mechanical excellence.

National Advertising of Certified Fleur-O-Liers Calls For:

1. **Plus loads in lighting . . . in commercial and industrial uses.**
2. **High Intensity lighting in offices, stores and factories.**
3. **Recommendations that buyers seek the advice of lighting company engineers for proper installations.**

Cooperative Program for Better Service—Bigger Markets

Through the cooperative advertising of Fleur-O-Lier Manufacturers, your customers have the benefit of knowing that Fleur-O-Lier equipment *must* bear the certification label of the Electrical Testing Laboratories. Therefore, it is for *your* protection and advantage to:

- **Demand this E.T.L. Certification Label when you buy equipment using MAZDA F Lamps.**
- **Advertise the E.T.L. Certification label locally.**
- **Discuss this E.T.L. Certification of Fleur-O-Liers with wholesalers and contractors in your territory.**

Write today for further details and a list of Manufacturers. Fleur-O-Lier Manufacturers, 2121 Keith Building, Cleveland, Ohio.

The Manufacturer guarantees by affixing this Label that this FLUORESCENT LAMP AUXILIARY duplicates samples found by periodic examination to comply with SPECIFICATIONS FOR FLUORESCENT MAZDA LAMP AUXILIARIES
ELECTRICAL TESTING LABORATORIES
NEW YORK, N. Y.
FOR HIGH POWER FACTOR
PRELIMINARY
The Manufacturer guarantees by affixing this label that this Fluorescent Luminaire is a duplicate of samples found by periodic examination to comply with the minimum requirements as set up in the SPECIFICATIONS FOR LUMINAIRES, FITTINGS, AND EMBODIED AUXILIARIES FOR FLUORESCENT MAZDA LAMPS.
Because these specifications must include luminaires designed for a wide variety of lighting applications, this certification is in no sense an appraisal of their relative merit for any specific application.
ELECTRICAL TESTING LABORATORIES
NEW YORK, N. Y. 1039
A Copy of This Certificate Should
E·T·L
Appear upon Each Unit or Package
FLUORESCENT LIGHTING FIXTURES EMPLOYING EXISTING TYPES OF LAMPS ARE NOT RECOMMENDED FOR SCHOOLS, OFFICES AND SIMILAR LOCATIONS UNLESS LAMPS ARE SHIELDED FROM DIRECT VIEW
SPECIFICATIONS
THIS CERTIFICATION IS CONTINGENT UPON EMPLOYMENT OF CERTIFIED AUXILIARIES OF OVER 85% POWER FACTOR
REQUIRES ADDITIONAL CORREC
TION FOR GOOD POWER FACTO

Label of Certification for Fluorescent Lamp Auxiliaries having high power factor.

Label of Certification signifying that Fleur-O-Liers meet with over 50 rigid essential electrical and mechanical specifications for satisfactory service.

your copy

St. Louis, Mo.

FLEUR-O-LIER *Manufa* **MERS**

in larger quantities. However, the revenue remains surprisingly even. This is largely due to the difference in the block of the rate at which the kilowatt-hours are billed.

As a result of these eight months of experiment and work, we have catalogued this oven as a load-building appliance worthy of our continued support. We feel that this small oven contributes to the common sense of "better customer appreciation for electric service."

•

Informed Dealers Build Utility Load

By P. C. TUCKER
General Sales Manager
Arkansas Power & Light Company, Pine Bluff

Publication of an accurate month-by-month record of appliance saturation for the benefit of dealers has proved to be a vitalizing influence in the new sales policy undertaken by this company last year when the merchandising of major appliances was turned over to dealers. Availability of reliable saturation data has had the effect of concentrating dealer effort in a strictly selected field and has resulted not only in swelling new appliance sales but at the end of the first eight months of the program has placed 3,840 rebuilt appliances back on the lines. Sales by dealers for the first six months of the program were 25 per cent above those for the previous six months and 15 per cent above those for the corresponding period of the year previous.

First step in the preparation of the saturation data was a house-to-house appliance survey in each of the 55 counties served. Information obtained was transferred to bound booklets, printed by the sales promotion department, and distributed to dealers. Two major objectives were immediately attained. (1) The attitude of the dealers toward the utility was instantly changed from one of casual friendliness to sincere friendship. (2) The sales of appliances by dealers began to reach unexpected volume.

To keep this data up to date the monthly magazine *Geared Sales*, published for the dealers, carried reports of major appliance sales as reported by themselves. This dealer "news letter" brought the interests of the dealers and distributors closer to each other and closer to the utility as well.

In addition to supplying this information, the company set up a dealer-utility co-ordinator aided by five sales supervisors. This group worked with the dealers, lending assistance in conducting training schools, working on particularly difficult prospects and otherwise assisting individual dealers to increase their appliance sales.

The advertising program of the company was also revamped. "Buy appliances from your local dealer" became the theme of all ads. Advertisements stressing the comfort, economy and convenience of electric service were prepared around which it was possible for newspapers to work up tie-in pages with the dealers stressing their own brands and prices.

To aid dealers in their direct-by-mail advertising efforts the sales promotion department maintains a mailing service and any circulars or other advertising of dealers are mailed free, except for postage.

Enthusiasm of the dealers for this new program has worked wonders in load building. Satisfied to take its chances on increased revenue from increased load, our company has not been disappointed.

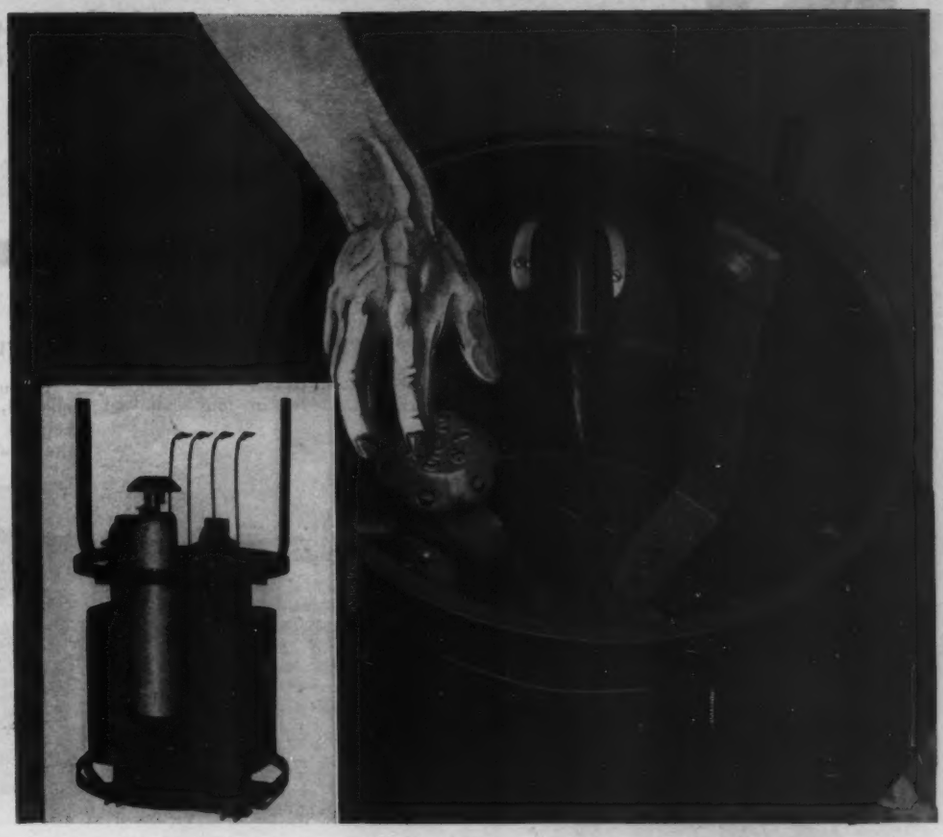
Dealer-Utility Co-operation Boosts Appliance Sales

Sales First Year of Program (1938) Vs. First Five Months 1939

1938, Total Residential Appliances—	Total Units For Year	Estimated Volume For Year	1939, Five Months Total Units Sold	1939, Five Months Estimated Volume
Portable floor and table lamps	14,099	98,693.00	4,540	48,997.00
Lamp bulbs (cartons)	75,809	$75,809.00	31,907	$31,907.00
Other lamps and lighting fixtures	14,294	57,176.00	6,490	19,394.00
Home ventilating systems	470	91,650.00	108	14,619.00
Air conditioning units	44	12,100.00	5	1,950.00
Heating plants	11	13,200.00	4	2,760.00
Refrigerators	6,100	1,128,500.00	3,074	564,895.00
Electric ranges	263	43,395.00	121	18,256.00
Electric water heaters	53	4,505.00	21	1,737.00
Radios	13,234	794,040.00	4,406	222,511.00
Table cookery devices	8,712	60,984.00	3,465	15,910.00
Other heating devices	11,382	56,910.00	4,812	16,728.00
Vacuum cleaners	1,530	91,800.00	638	34,902.00
Clothes washers	2,454	184,050.00	838	60,713.00
Portable fans	6,616	72,776.00	451	4,064.00
Other motor devices	3,343	120,348.00	1,370	26,652.00
Farm devices	204	20,400.00	353	17,602.00
Commercial Appliances—				
Refrigerators	189	94,500.00	205	132,110.00
Water and beverage coolers	144	23,760.00	114	23,850.00
Ranges	1	250.00	2	385.00
Counter cookery	22	660.00	4	395.00
Ceiling fans	31	1,550.00 }	90	11,306.00
Exhaust fans	15	1,500.00 }		
Attic fans	7	1,750.00	69	14,694.00
Large circulating pedestal type fans	128	8,320.00	.....	.....
Air conditioning units	5	15,000.00	19	46,800.00
Commercial lighting fixtures	1,588	15,880.00	4,189	29,450.00
Commercial washers	1	250.00	3	225.00
Washed air systems	2	550.00	6	1,775.00

D FT.-CANDLES TOO B'GOSH—The cutting room of the Osh-pany increased its illumination from 6 ft.-candles to 60. Inten-watt reflectors are used over the center of the table. Costly ve been reduced. Installation is in territory of Wisconsin

CHANGE TAPS *Above* OIL LEVEL!



NO NEED TO REACH DOWN INTO HOT OIL TO CHANGE TAPS ON THESE MOLONEY TRANSFORMERS

It is no longer necessary to change link connections or operate ratio adjuster handles located below the oil level when changing taps . . . Ratio adjusters with operating handles conveniently located *above* oil level are supplied as standard equipment on *all* Moloney Conventional Distribution Transformers on which taps are regularly furnished.

Ratio adjusters eliminate the possibility of error in making tap connections. The operating handle is clearly marked so that the operating tap position can be quickly and accurately determined. The handle is located above the hot oil level, making the operation of changing taps a simple operation that can be accomplished conveniently and rapidly.

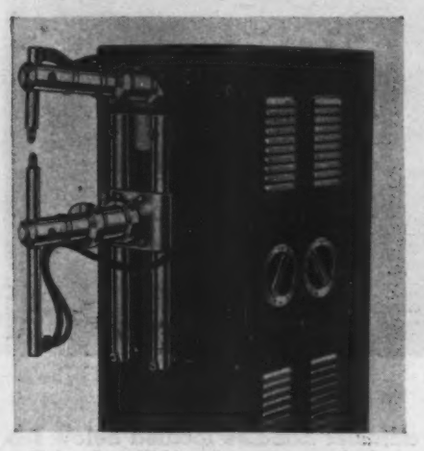
This is but one of the many features of the new Moloney Transformers. Send today for your copy of Bulletin D-390222 describing these transformers in detail. Moloney Electric Company, St. Louis, Mo.

MOLONEY TRANSFORMERS

NEW EQUIPMENT

Spot Welders

Two new models are offered by this company, one motor driven automatically operated and one manually operated by means of a swivel-jointed foot treadle.



50 kw. Spot Welders for spot or projection welding, and, with suitable fixtures, for butt welding for operation on 220-volt, 60-cycle supply. **Pier Equipment Mfg. Co.**, Benton Harbor, Mich.

New features are recessed automatic trip control and timing adjustment. They have an 8-point heat regulating switch for adjusting secondary voltages and current and a new 300-ampere contactor. Four throat depths are available and lower horn may be adjusted to provide spacing up to 15 in. on standard welders.

•

Wire Stripper

Power-driven, brush-type wire stripper, model "9-C." **Ideal Commutator Dresser Co.**, Sycamore, Ill.

Operation of this wire stripper is by single, direct-belt drive from the ¼-hp. motor. The speeds of the brushes are synchronized through an auxiliary, flat-belt drive which also operates a vacuum exhaust.

•

Colorimeter

Photo-electric colorimeter "Lumetron"; covers a wide range of application. **Dr. F. Loewenberg**, 10 East 40th St., New York, N. Y.

The "Lumetron" colorimeter uses two blocking-layer photocells in a balanced circuit. It is claimed that this makes it possible to operate the instrument from the power line without the use of batteries or constant-voltage transformers. The instrument comes in four standard models.

•

Planograph

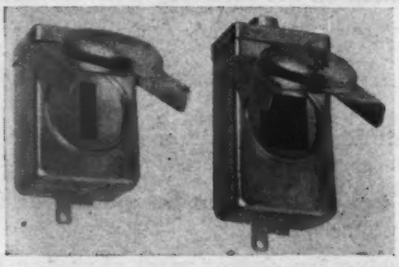
"Airco No. 10 Planograph," to cut lines from ferrous metals. Operates on 110 or 220 volts a.c. or d.c. **Air Reduction Sales Co.**, New York, N. Y.

This planograph consists of torches and tracing devices supported on the carriage which travels on a tracing table. The devices for magnetic and templet tracing can be interchanged in the existing head. The magnetic tracer, connecting directly to an electrical outlet located near the top of the tracing device head, requires 110-volt d.c. for operation. Cutting range in single-torch operation is 24 in. wide by 72 in. long. Maximum diameter of circle cut is 24 in.

•

Equipment Protector

The company states that this protection is ideal for the 600-watt transformers of the rural type, as well as the larger sizes of transformers. The protector may be located in any position on the pole, be-



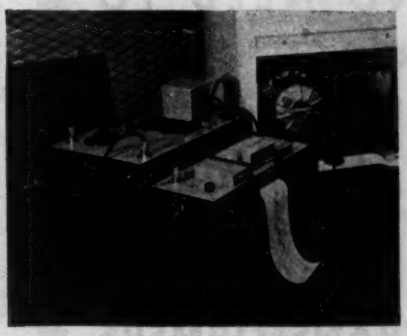
"Protector" operating on magnetic principle only, opens secondary on current from 50 milliamperes to 50 amperes; for two- and three-wire services. **Walker Electrical Co.**, Atlanta, Ga.

low the transformer, making it accessible from the ground to the customer. It is dead front and the live parts can be sealed to prevent tampering.

ELECTRICAL EQUIPMENT BUYERS look first in "Electrical World" *Electrical Buyers Reference* for names, addresses and products of manufacturers.

Frequency Analyzer

Frequency is employed by the "sweep" method, using a small drive motor to actuate the frequency dial which sweeps the whole range of frequencies from 30 to



Recording frequency analyzer "industrial stethoscope" for use of acoustic engineers engaged in the diagnosis and checking of running machinery. **Electrical Research Products Inc.**, New York, N. Y.

10,000 cycles per second. With this motor is synchronized another motor driving a band of graph paper on which a stylus traces the sound level at each frequency passed. Having tested both good and defective machines in this manner, the symptoms of the defects most chronic to the type of machine tested can be detected by the eccentric sound peaks at certain frequencies.

•

Industrial Lamps

New white-bowl industrial lamps in sizes ranging from 150 to 1,500 watts. **Westinghouse Lamp Division, Westinghouse Electric & Mfg. Co.**, Bloomfield, N. J.

Designed for industrial uses in RLM direct-lighting reflectors, these white bowl lamps may be used in any position without causing premature blackening. Previously these lamps were designed for base-up burning only.

•

Air Conditioning Units

A new line of commercial-sized economizer units and sectional dehumidifiers for large air conditioning installations. **York Ice Machinery Corp.**, York, Pa.

Combination indoor cooling towers and water cooled condensers, new economizers are designed to permit operation with more than one compressor. There are

—NOR DOES A POLE LINE

FEEL THE BITE

OF A SINGLE DAY'S EXPOSURE. BUT IF THE ELEPHANT WERE TO WITHSTAND AN ATTACK BY COUNTLESS INSECTS HE WOULD NEED A HIDE AS TOUGH AS HUBBARD, DOUBLE-DIP GALVANIZING WHICH PROTECTS HUBBARD HARDWARE FROM THE CORROSIVE BITE OF THE ELEMENTS YEAR AFTER YEAR.

HUBBARD AND COMPANY

PITTSBURGH — OAKLAND, CALIFORNIA — CHICAGO

"HANG THE LOAD ON HUBBARD HARDWARE"

Because they measure speed simply by contact

"FRAHM" VIBRATING-REED TACHOMETERS

are the solution to a wide variety of speed-measuring problems, as well as for indicating rates of vibration. Types for permanent mounting as well as for hand use.

Write for descriptive Bulletin 1590-W.

JAMES G. BIDDLE CO. 1211-13 ARCH STREET PHILADELPHIA, PA.

SHERMAN

SOLDERLESS LUGS FOR TRUE LUG ECONOMY

Wherever a lug is needed you can select the proper type from the practical, economical Sherman line of Electrical Products. Sherman Solderless Lugs have been designed and manufactured to insure proper electrical and mechanical performance. For true lug economy Sherman is the name to remember. Sold thru Jobbers.

Truly practical and flexible in design — interchangeable with Regular Soldering Lug mountings and can be made to suit peculiarities of equipment design. Easy and quick to use — require no special tools—Heavy Duty design. Send for Bulletin No. 15 for superior performance.

SM TYPE SOLDERLESS LUG

Inexpensive one-piece design and because of small size can be used in places where other lugs are too bulky. Rigid assembly—wire can't shake loose—compact—no special tools required. Screw can be removed and solder dropped in if desired. Direct contact insures highest conductivity. Send for Bulletin No. 24.

H. B. SHERMAN MFG. CO.

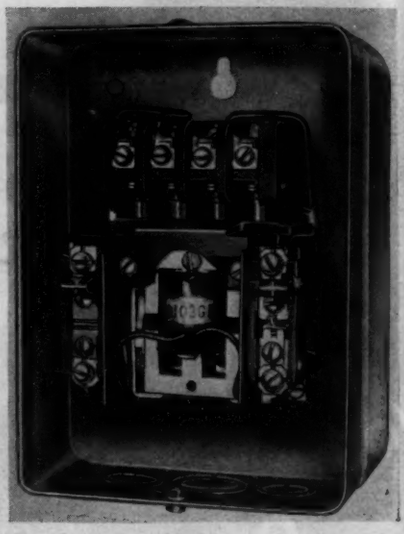
Battle Creek, Michigan

three models for smaller applications and two for larger applications. New type "MC" dehumidifier offers full air washing with multiple finned coils similar to those used in dry coil units.

•

Magnetic Starter

For applications which require starters for fractional horsepower motors and motors up to 2 hp. with undervoltage protection and which can be interlocked with other starters, this new starter consists essentially of a 3- or 4-pole contactor with two hand or automatic reset isothermic temperature overload relays mounted on the contactor frame, and enclosed in a case. One pole of the contactor is used as a holding interlock, extra interlocks can be added.

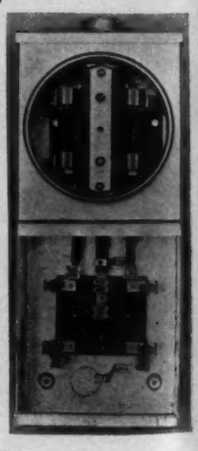


Type "M-2" magnetic starter for industrial applications. The Trumbull Electric Mfg. Co., Plainville, Conn.

•

Meter Trough

New form of trough mounting for socket type meters, or instruments, has turtle neck meter settings formed directly from the individual covers of the trough. May be used for indoor or weather proof service.



Meter troughing equipment available for single meter installations and for horizontal or vertical plural type "S" meter settings. The Palmer Electric & Mfg. Co., Wakefield, Mass.

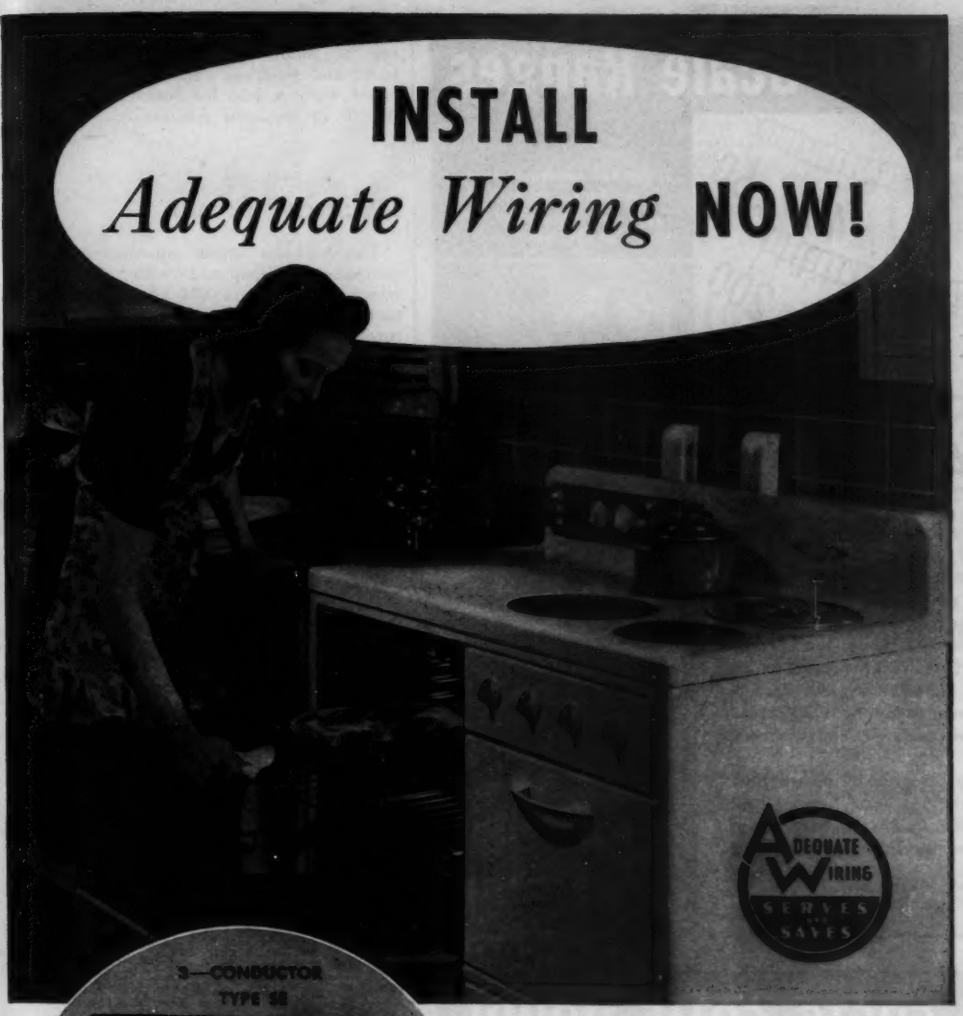
•

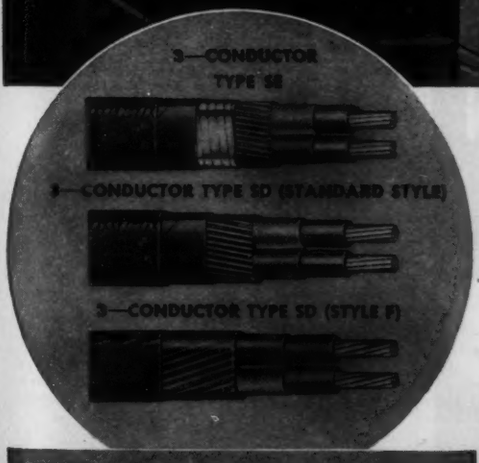
Control Station

Three-button control station maximum d.c. rating of 1 amp., 115 volts; 0.5 amp., 230 volts; 0.25 amp., 550 volts; maximum ac. is 3 amp., 110-, 220-, 440-, and 550-volt. Allen-Bradley Co., Milwaukee, Wis.

This new station is available with various button markings, including "Forward-Reverse-Stop," "Raise-Lower-Stop," "Up-

INSTALL *Adequate Wiring* NOW!





AMERITE
SERVICE ENTRANCE
and
DROP CABLES

SERVICE change-overs are made easy and economical with Amerite service-entrance and service-drop cables. There is a type for every purpose. "Tamperproof" cables (see cuts) eliminate diversion of current.

TYPE SE —Tamperproof Service Entrance cable. May be attached direct to building walls.

TYPE SD —Tamperproof Service Drop cable. May be run from pole to meter in one continuous length if properly protected where it contacts walls of building.

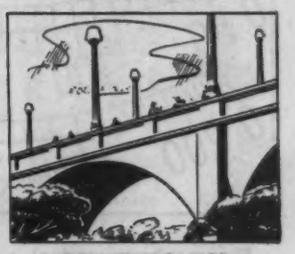
TYPE ASE—"Protected" type for use in places where exposed to mechanical injury.

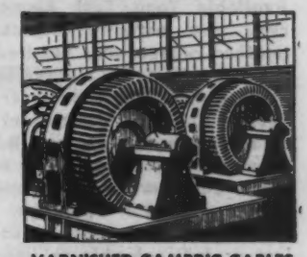
TYPE USE—Underground type for direct burial in earth.

We also furnish 5-conductor Service Entrance cables, useful for rewiring houses with Service Entrance in the attic.

Let us send you our Catalog of Service Cables.

BUILDING WIRES


PARKWAY CABLES


VARNISHED CAMBRIC CABLES

AMERBESTOS CABLES

TREE WIRE

AMERCLAD CORDS & CABLES

AMERICAN STEEL & WIRE COMPANY

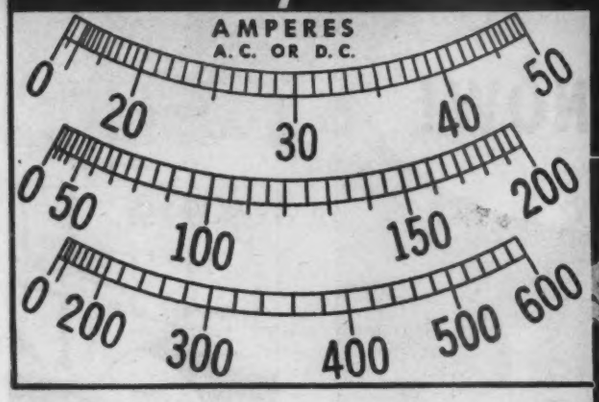
Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*

United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Ten Easily Read Scale Ranges



A typical combination of ranges furnished with the Type AX Tong Test are shown at the left.

Shown above, actual size, are three of the ten available Tong Test Ammeter scale ranges. Easily read and instantly interchangeable, they are but another reason why hundreds of service men prefer the Tong Test for measuring current.

More important, however, is the fact that Tong Test is the only instrument of its kind capable of measuring both A.C. and D.C. without shunts, transformers or MV meters. It measures up to 1,000 amperes and can not burn out because it contains no coils, switches or rectifiers.

Tong Test is as easy to use as a pair of pliers and just as indispensable to your service men. Why not send for the Tong Test bulletin and see why more and more leading utilities are buying Tong Tests?

COLUMBIA ELECTRIC MFG. CO.
4529 Hamilton Avenue **Cleveland, Ohio**

TONG TEST AMMETERS

CONNECTION COSTS COME DOWN

when

SERVITS GO UP!

Speedily installed, Servits remain permanently secure under the most severe operating conditions. Result—*lower cost per connection!*

BURNDY
459 E. 133 ST.
NEW YORK, N. Y.

"Down-Stop" and "Open-Close-Stop." It can be mounted in either a vertical or horizontal position. Also, it may be provided with a bar for locking the "Stop" button in its open position.

•

Hacksaw Frame

The hacksaw frame announced by this company is insulated with "Cohardite" which it claims is not affected by moisture, oil, acid fumes or extreme temperature. Utility and safety men will find

"Cohardite"-insulated hacksaw frame; takes a 12-in. blade; tested to 20,000 volts. **The Connecticut Hard Rubber Co.**, New Haven, Conn.

them useful. Among other tools insulated with this material, offered by this company, are an adjustable head wrench and chipping knife.

•

Heating Units

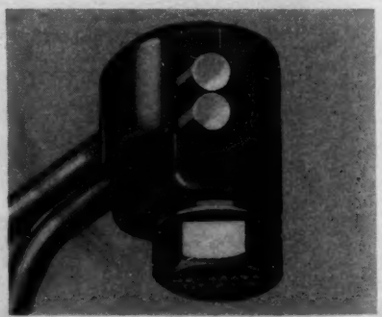
A new line of portable "Heetaires," 115 volts. **Markel Electric Products, Inc.**, Buffalo, N. Y.

Two types of forced heat are provided by these new heaters—direct radiant heat from a glowing red element and chromium reflector and hot-air heat circulated by a fan. There are two elements and two switches so that either radiant or forced heat or a combination of both may be used.

•

Connector

Built in one unit, this connector is just hooked on the run-wire, the tap inserted



Series "6000" connector available in No. 6 and No. 4 sizes. **Fargo Mfg. Co.**, Poughkeepsie, N. Y.

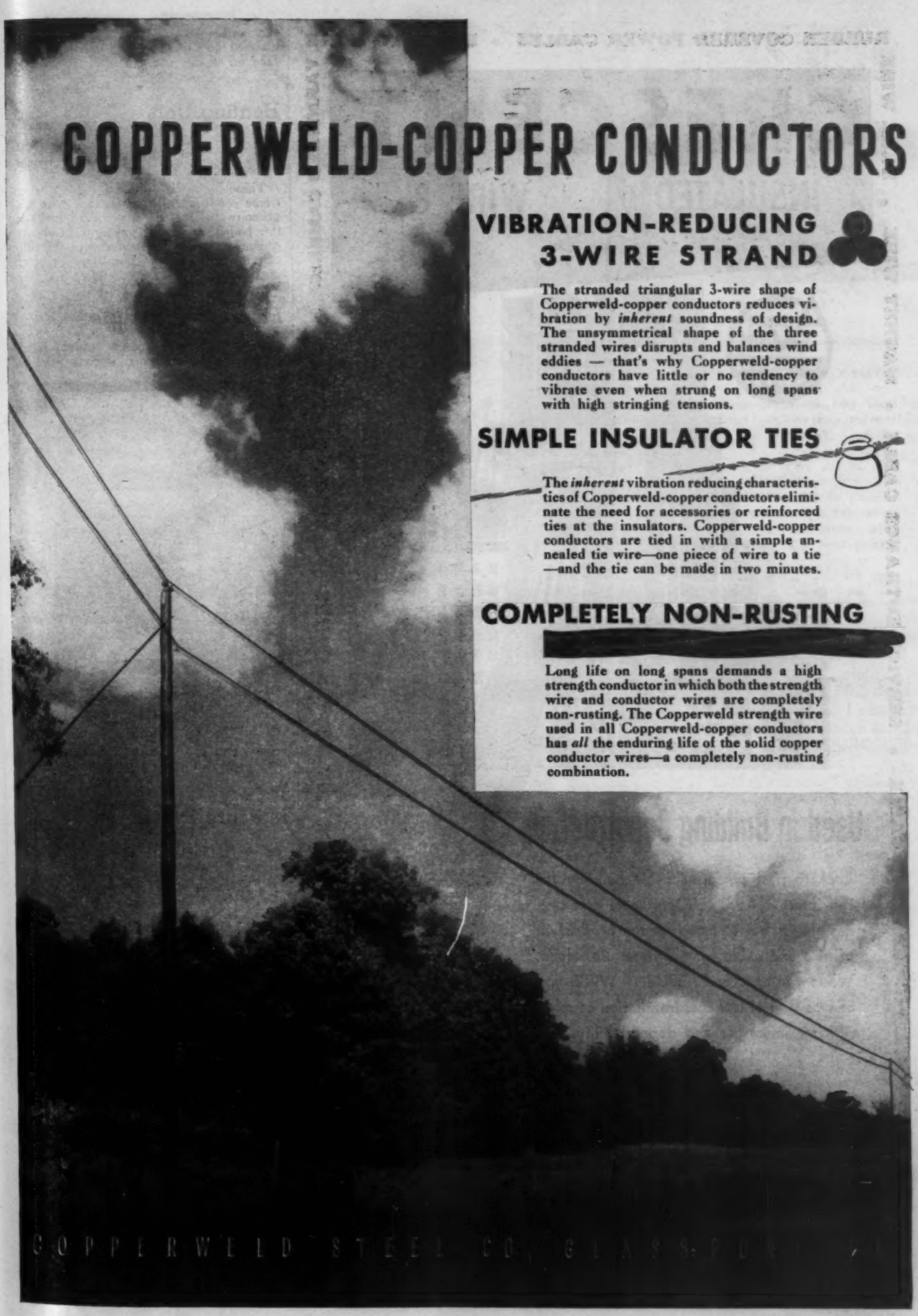
and the bolt tightened. They claim the serrated jaws cause no slipping inside.

•

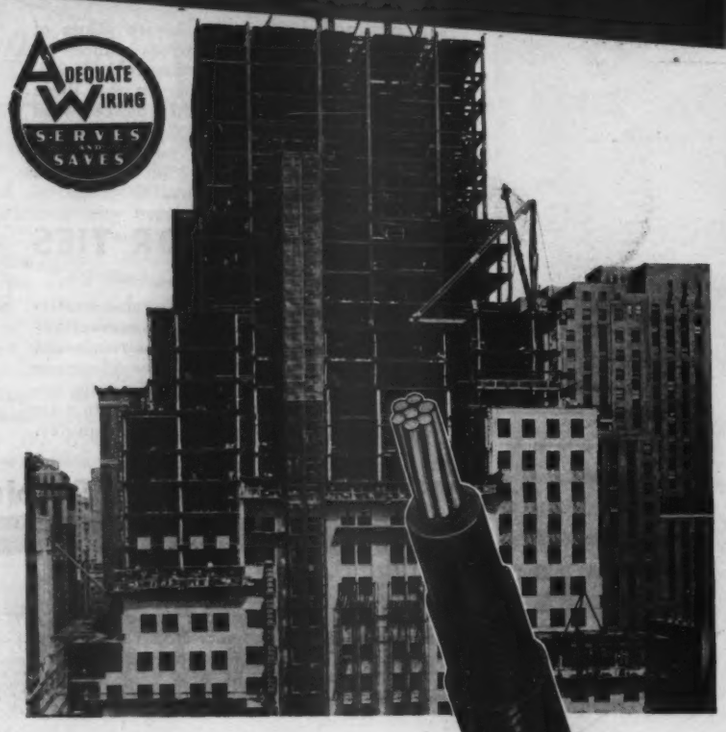
Wire-Wound Resistor

"Ohiohm" ceramic-insulated wire-wound resistor for motor-starters, relays and on photoelectric safety and counting devices; standard units from 5 to 20 watts in resistance value range. **The Ohio Carbon Co.**, Cleveland, Ohio.

Compactness is obtained by the use of axial terminal wires instead of the usual projecting side-lugs; the elimination of


COPPERWELD-COPPER CONDUCTORS
VIBRATION-REDUCING 3-WIRE STRAND
The stranded triangular 3-wire shape of Copperweld-copper conductors reduces vibration by *inherent* soundness of design. The unsymmetrical shape of the three stranded wires disrupts and balances wind eddies — that's why Copperweld-copper conductors have little or no tendency to vibrate even when strung on long spans with high stringing tensions.
SIMPLE INSULATOR TIES
The *inherent* vibration reducing characteristics of Copperweld-copper conductors eliminate the need for accessories or reinforced ties at the insulators. Copperweld-copper conductors are tied in with a simple annealed tie wire—one piece of wire to a tie —and the tie can be made in two minutes.
COMPLETELY NON-RUSTING
Long life on long spans demands a high strength conductor in which both the strength wire and conductor wires are completely non-rusting. The Copperweld strength wire used in all Copperweld-copper conductors has *all* the enduring life of the solid copper conductor wires—a completely non-rusting combination.

RUBBER COVERED POWER CABLES • BUILDING WIRE • VARNISHED CAMBRIC • FLEXIBLE CORDS • LEAD ENCASED AND PARKWAY CABLES • ARMORED CABLE
CRESFLEX NON • METALLIC SHEATHED CABLE • SERVICE ENTRANCE CABLE • MAGNET WIRE • BARE WIRE



Used in Building Construction

Look to past performance in building for the future. At CRESCENT sole emphasis has always been placed on the production of wire and cable for electrical use, alone. When you specify CRESCENT WIRE, you can be sure of low cost installation coupled with maximum life and dependability.

CRESCENT
INSULATED WIRE & CABLE CO. INC
TRENTON, NEW JERSEY

Atlanta Baltimore Boston Buffalo Chicago Cincinnati Cleveland
Detroit Indianapolis Kansas City Los Angeles Minneapolis
New Orleans New York Philadelphia Pittsburgh St. Louis San Francisco

CRESCENT ENDURITE SUPER-AGING INSULATION

the end-bands. The porcelain core is claimed to have a large radiating surface on inside and outside.

•

Heating Unit

Immersion heating unit, "Type IR" Senior; supplied up to 6 kw., 230 volts, single- or three-heat, and single- or three-phase. **Harold E. Trent Co.**, Philadelphia, Pa.

These units are designed for the extreme condition of high wattage with high pressure (of 900 lb. per square inch) on the bodies and with gas-tight heads, the company claims. The material of the tubes can be suited to the requirements of the application.

•

Fluorescent Fixture

This fluorescent fixture which is designed for illuminating various sizes of

Fluorescent lighting fixture; uses 15-watt, four 20-watt, four 30-watt or four 40-watt fluorescent lamps. **Lighting Div., Johnston Hardware Co.**, New Kensington, Pa.

rooms, and can be used with or without the suspended glass shade.

•

Mercury Switch

Delayed-action mercury switches, an addition to the standard line of "Kon-nec-tor" mercury switches; time-delay intervals of from ½ to 15 sec. for circuit opening, ½ to 10 sec. for closing. **Lamp Dept. of General Electric Co.**, Hoboken, N. J.

These switches are operated either mechanically by means of a lever or cam action, or electrically by means of a solenoid. The delayed action characteristic is obtained by the restricted flow of mercury through a small orifice at the bottom of a metal chamber inside the switch. When the "Kon-nec-tor" is tipped, mercury flows into the chamber, then through the orifice until the circuit is opened or closed, depending on the type of switch.

•

Multi-Breaker

Type "M2" multi-breaker, 2-pole, 100 amp., frame; designed for 3-wire solid neutral, 115/230 volts, a.c., insulated groundable neutral; 2-pole, 115/230 volts, a.c., no neutral; capacities 50, 70, 90 or 100 amp. **Square D Co.**, Detroit, Mich.

This breaker is common trip, i.e., over load on one pole automatically trips both poles simultaneously. The company claims the breaker to be trip free and cannot be held closed on a short circuit or over load.

MANUFACTURING - MARKETS

G.E. Workers to Get $4,750,000 Extras

Under the general profit-sharing plan of General Electric Co., and based on an estimate of 1939 income, approximately $2,400,000 will be available for distribution to employees for the current year, as against $557,000 for 1938, according to Gerard Swope, president.

The employees will also receive approximately $2,350,000 as a cost-of-living adjustment of their earnings for 1939, as against $3,298,000 for 1938. Under these two plans total additions to regular earnings of eligible employees will be $4,750,000 for 1939, against $3,855,000 for 1938.

In August the employees received a payment from earnings under the profit-sharing plan for the first six months, and on or about December 20 payment will be made for the second six-month period. Total disbursements to employees with five or more years of service will be 5.75 per cent of regular earnings for the second six months this year.

The company now has about 67,000 employees, or 10,000 more than a year ago, Mr. Swope said.

•

York Ice Reports 42% Rise in Orders Booked

A 42 per cent increase in orders booked during the past five months over those of the similar period last year is reported by William S. Shipley, president of the York Ice Machinery Corp. During the five-month period from June 1, 1939, to November 1, 1939, orders booked totaled $6,501,499, against $4,576,831 for the same period last year.

"This increase is in line with general business conditions. Our volume in the past five months was 18 per cent greater than for the same period in 1937, and if this is any indication of what we can expect in the near future the coming year should hold real promise," Mr. Shipley stated.

•

NEMA Announces New Appliance Indexes

Sales billed for major appliances in 1939 have been consistently higher than in corresponding months of 1938, it is indicated in two new series of indexes compiled by the statistical department of the National Electrical Manufacturers Association. One of these refers to refrigerators, the other to other major appliances. Each is based on the 1936 average, taken as 100.

In the case of refrigerators, the September index, 41.4 (not seasonally adjusted), was about 15 per cent higher than a year ago. September sales are normally below the yearly average. When this is taken into account the adjusted index becomes 92.4.

For other major appliances this year's September index (unadjusted), 104.5, was 27 per cent above last year's; the adjusted figures are the same as the unadjusted.

As announced by NEMA, the new monthly index numbers are carried back to January, 1934. The first nine months of 1938 and 1939 are covered in the accompanying abstract.

NEMA Index Number, Unadjusted
(1936 average = 100)

	Refrigerators		Other Appliances	
Month	1939	1938	1939	1938
January	87.6	60.8	98.6	73.4
February	116.9	84.0	101.9	84.6
March	142.3	100.9	126.0	103.1
April	147.3	123.2	107.3	94.9
May	154.9	104.0	120.2	87.8
June	152.0	60.8	111.6	82.2
July	92.9	51.5	84.9	75.5
August	53.6	53.9	99.6	84.7
September	41.4	36.1	104.5	81.9

Westinghouse Sees Gain in Appliances

Westinghouse Electric & Manufacturing Co. is looking forward to "one of our biggest years" in 1940 in the sale of electrical appliances, according to Frank R. Kohnstamm, sales manager of the merchandising division. Mr. Kohnstamm said that a series of preview meetings starting next January 2 will inaugurate the new line of products.

"We are expecting a substantial sales increase next year and as a result we have stepped up our entire program," Mr. Kohnstamm said. "An increased advertising appropriation to build greater consumer acceptance and an increased effort on sales training are two of the highlights of next year's plan, all of which have been carefully laid with our retailers' problems foremost in mind."

The first distributors' meeting will be held December 4 and 5 in Mansfield, Ohio. This will be followed by a meeting on December 6 to 8 for district sales personnel. District meetings in fifteen cities, starting after December 26, will be held for the purpose of presenting the 1940 plan and training of the sales organization.

•

Washer-Ironer Week Stimulates Sales

Household washer shipments in October were largest, excepting one month, since September, 1937, totaling 142,830, an increase of 24.18 per cent over 115,019 washers shipped in October, 1938, according to industry figures reported by Joseph R. Bohnen, executive secretary-treasurer of the American Washer & Ironer Manufacturers' Association.

Observance of the second annual National Washer-Ironer Week in October by stores throughout the country was

ROME-CABLE
ROME, N.Y.

Hot Rolled Copper Rods • Bare and Tinned Strand
Bare and Tinned Copper Wire
(In Rounds, Flats and Squares)
URC Weatherproof Wire
Cotton, Paper and Asbestos Magnet Wire
(In Rounds, Flats and Squares)
Rubber Insulated Wires and Cords
Lead Covered Cables • Multiconductor Power Cables
Network, Service Entrance, Control Cables

ROME-60
That New, Tough, 60% Jacketed, Heavy Duty Portable Cable

ROME CABLE
CORPORATION
ROME, N.Y.
SALES OFFICES:
New York Chicago Cleveland Pittsburgh Detroit
Boston Richmond Philadelphia Los Angeles

SERVICE RECORDS TELL THE STORY

"Dixie"
DENSE LONGLEAF PINE

JACKSON LUMBER COMPANY
POLES
DIXIE
PILING
LOCKHART, ALABAMA

POLES, PILING
& CONSTRUCTION LUMBER
CREOSOTED OR "WOLMANIZED"
For Quotations address: Treated Products Division

JACKSON LUMBER COMPANY
MACON, GEORGIA
A CROSSETT WATZEK GATES INDUSTRY

given credit by Secretary Bohnen for a substantial part of the manufacturers' gain over the same month in 1938.

October's gain of 24.18 per cent compares with a gain of 10.47 per cent in September, when washer shipments were 138,992, against 125,821 in September, 1938. Washer shipments for the ten months are 1,252,996, an increase of 27.09 per cent over the same period in 1938.

Ironer shipments in October aggregated 11,161, compared with 10,523 in October, 1938, and 10,565 in September, 1939. Shipments in the ten months totaled 93,380, compared to 93,104.

•

Air Conditioning Orders Show Gains of Industry

Orders booked for air-conditioning systems and equipment during September, as reported by 267 manufacturers, totaled $8,057,928, as against $6,502,798 in August, according to the Department of Commerce. For the first nine months orders aggregated $50,927,499.

Comparative figures are not available on the same basis for previous years. Statistics for 125 manufacturers show this year nine-month orders totaling $40,546,771, as against $30,748,172 for the same period a year ago.

•

Business Up 30 Per Cent

Earl H. Martindale, president of the Martindale Electric Co., Cleveland, Ohio, states that business in November of 1939 has been about 30 per cent better than at the same time last year, and slightly better than the 1937 rate. Foreign orders are about double what they were in 1938, he said.

•

Adds Plant Equipment

Business of Proctor Electric Co. has shown a substantial increase over last year, according to Walter M. Schwartz, Jr., president. Additional plant equipment has been installed to accommodate the increased production requirements.

New York Metal Prices

	Nov. 28, '39 Cents per Pound	Nov. 21, '39 Cents per Pound
Copper, electrolytic	12.50*	12.50*
Lead, A. S. & R. price	5.50	5.50
Antimony	14.00	14.00
Nickel, Ingot	35.00	35.00
Zinc, Spot	6.89	6.89
Tin, Straits	54.00	51.50
Aluminum, 99 per cent	20.00	20.00

*Delivered Connecticut Valley.

Field Reports on Business

There is little likelihood that the electrical industry will suffer to any great extent should there be a seasonal reaction in business early next year. So far the backlog of orders will keep production schedules going well into 1940. Utility budgets are higher.

NEW ENGLAND

Orders for electrical equipment placed by textile plants were an interesting feature of the trend in this district during the past fortnight. Last week a motor order amounting to about $40,000 was booked for a Massachusetts textile plant; a prominent woolen mill has bought a 4,000-kw. turbo-generator and switch and control equipment buying has been steadily increasing among both cotton and woolen mills.

The upward swing in industrial activity in the Connecticut area is still very pronounced where a scarcity of skilled workers is now looming. The Rhode Island district is experiencing similar higher levels in industrial activity. Employment in textile plants in this area is the highest in two years.

Production of 1940 refrigerators will be stepped up in the East Springfield, Mass., plant of Westinghouse Electric & Manufacturing Co. G.E. has more orders for power station equipment and reports a high peak of activity in the River Works, Lynn. Orders on hand at present are a 50,000-kw. turbo-generator for the Public Service Electric & Gas Co., Jersey City, a 40,000-kw. unit for Providence, R. I.; 35,000 kw. for Consumers Power Co., 20,000-kw. unit for the new Glendale, Cal., municipal station, and the recently bought 12,500-kw. unit which will go into the new 20,000-hp. steam plant to be erected by the Central Maine Power Co. at Bucksport, Maine.

Municipalities are planning for an encouraging amount of electric lighting display during the coming holiday season. New construction supplies are moving at a good pace. Slowly rising trend in merchandising is reported, with a strong demand for new laundering appliances.

PACIFIC COAST

Despite predictions that the Pacific Coast would experience a building recession parallel to that of 1937-38, October recorded a total 15 per cent increase over September in seven Western states.

Industrial business includes 4,000-volt motors totaling 5,000 hp. to run the 10-mile conveyor belt for Shasta Dam aggregate, the total electrical equipment for this construction short cut being $250,000 in value. A gold dredging outfit has bought $5,000 of sizes 20 to 100 hp. motors, auxiliaries for a steam plant serving the Avon Oil Refinery cost $14,000, a four-unit switching equipment for another refinery at Martinez cost $15,000, a gold mine bought a 1,750-kva. generating equipment for $16,000 and a shipbuilding firm $12,000 of arc welders. San Francisco plans to add 2,000 hp. to its pumping plant and a street railway company has bought trolley coach electrical equipment, value $14,000.

Prospective Bonneville plant and system business includes insulators for 115- and 196-kva. transmission lines, radio telephone apparatus for fixed and mobile stations, the first leg of the Hood River and The Dalles line crossing, with 240-ft. towers and beacons, besides two carloads of annealed copper for Columbia basin project. Power company purchasing has been steady, though not spectacular, a typical order being $32,000 cutouts, small transformers and circuit breakers for central stock in northern California.

NEW YORK

The Christmas shopping trade got under way in full boom this week with stores crowded and sales reported ahead of last year. Many outlets report good stocks, with prices holding steady. It is estimated that the Christmas trade will be about 10 per cent ahead of last year. Consolidated Edison has sold more than 80,000 of its 100,000 goal of the General Electric combination radio-phonograph models during the present drive.

Plans under way here to expand housing consider several large projects.

Electrical manufacturers are optimistic over the outlook for next year. Orders booked have created a backlog which will carry production schedules well into next year. Utility budgets will be higher than in many years past, with expenditures well distributed. Much line work is contemplated with strengthening of distribution and transmission systems. Substation work is due for a big lift.

The offering of $52,500,000 of bonds and debentures of Public Service Co. of Colorado this week, after almost a year's delay, offered bright prospects for additional utility financing in the future. Several other large issues are due to come into the market in the near future.

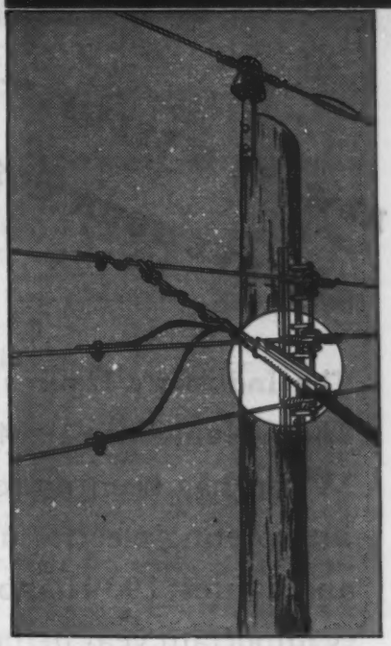
CHICAGO

Mixed tendencies were apparent in last week's business developments. There was some slackening noted in new orders for equipment, but industrial activity continued at high levels, with sufficient backlog to carry on at the present rate through the year-end. Although holiday trade is rapidly gaining momentum, department store sales last week declined 9 per cent from a year ago. Electrical power output also showed a decrease from the previous week to a point 15 per cent above the corresponding period last year.

Industrial plant expansion projects are going forward at an encouraging pace. Since November 1 thirty plants have announced building programs with an aggregate expenditure totaling $3,300,000. Actual work started on the $6,400,000 construction program of the Public Service Co. of Indiana, when the 41-mile 132,000-volt transmission line got under way. Other phases of the project scheduled to begin this month are the 50,000-kw. additional generating capacity at Dresser, Ind., costing $4,000,000 and a $300,000 substation at New Castle, Ind.

Wholesale trade in twenty major classifications at the Merchandise Mart for the first fifteen days of November averaged 20 per cent in excess of sales for the comparable period of 1938. Major electrical appliance sales showed an increase of 44 per cent.

modernize
YOUR
DISTRIBUTION
PRACTICE —



Residential area construction — showing single phase primary with attachment of service cable a couple of feet from pole to high strength common neutral wire.

RELIABLE CONCENTRIC CABLE CLAMPS

hold cable securely without bending or snubbing or otherwise damaging the insulation. Non-corrosive materials — easy to install — low in cost.

Reliable
ELECTRIC COMPANY
OVER 25 YEARS SERVICE TO THE UTILITIES

Another FACTS and FIGURES BOOK

ALWAYS A SELLOUT—
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The Industry's Figures and What They Mean. Since 1904 Electrical World has been presenting and interpreting electric utility facts and figures; 1939 has been a pretty important year in the industry. Just how important is not fully realized until you see the figures, look at the record—and compare 1939 with previous years.

• In this one convenient package the January 13 issue of Electrical World gives you a clear-cut, accurate picture of just where the electrical industry stands today and what may be expected of it during the year ahead. • Complete presentations of nation-wide phases of power company operation and management make this one number the most looked-for, looked-at, looked-up periodical in your field. Use the handy coupon and mail your reservation today.

In addition to the customary data, the 36th Annual Statistical Number includes

TWO NEW EXTRA FEATURES

Output Curve from 1902-1940 — One of the most widely used features in Electrical World is the weekly output curve, index of the electric utility industry.

We believe that a chart that would show the trend of the output curve from way back would not only be interesting but valuable to manufacturers and electrical engineers as well as utility men. So in your copy of the January 13 issue there will be included, as a supplement, the graph of electricity output for 1902-1940.

To make it more useful for reference purposes, this pull-out folder chart will be large enough to slip under the glass top of your desk or hang on the wall. Space for 1940 will be left so you can add to the curve the weekly output figures as they are reported in Electrical World. Other small graphs on the sheet will include such information as Residential, Commercial, Industrial energy consumption.

Two Decades in Electric Utility Industry — At the end of a decade, it is interesting to see what changes have taken place in life about us. In the utility industry it is interesting not only to note the changes that have occurred in the past ten years but also to compare 1929-39 with 1919-29.

The 20's saw the most rapid growth of the electrical industry. By contrast, it is generally thought that the electric utility industry made small progress in the 30's. This idea is often brought out as a criticism of the industry's initiative. But this idea is not correct, nor even largely so . . . as will be demonstrated in two pages of graphic data in the 36th Annual Statistical Number, January 13 issue.

is in the Works . . . !

EVERY ELECTRICAL MAN, regardless of the position he holds, will want a personal copy of this most widely-used and consulted issue of the year . . . because it contains "all the answers."

The "answers" will affect every man in the electrical industry. Only by reading, first-hand, your industry's leading technical and news publication—Electrical World—can you hope to keep fully informed on these vital subjects and know about their influence on your own work and rewards.

If Your Interest is in ENGINEERING & OPERATING you will find in this issue up-to-the-minute figures on—

energy output . . . generating capacity . . . new stations, completed and scheduled . . . fuel consumption—average hours of use, plant loading, capacity factor—and other station operations.

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operating expenses, including maintenance and wages . . . operating ratios . . . increases in taxes . . . amounts and terms of security issues, bonds maturing, etc. . . . the 1940 prospective capital expenditures in terms of prime mover, transmission, distribution and miscellaneous, with the total investment by type of property.

In short, the January 13 issue—36th ANNUAL STATISTICAL NUMBER—will give you much more than just figures. It will present vividly to every electrical man a dramatic, timely picture of the opportunity for developing the electric power industry in 1940.

With essential facts and figures, interspersed with concise interpretations, the 36th STATISTICAL NUMBER of Electrical World shows—

- ★ **What additions were made to Power Plant Capacity during the year.**
- ★ **What Additional Capacity is planned for '40 and '41.**
- ★ **What the total Generating Capacity was for '39.**
- ★ **How rapidly Domestic Consumption is rising.**
- ★ **What the total Capacity is in each state—Steam, Hydro, etc.**
- ★ **How much average Rates Decreased. (Industrial, Residential & Commercial).**
- ★ **How many New Customers in each state (by classes).**
- ★ **What the prospects are for New Substation Capacity.**
- ★ **How fast Rural Service is being extended.**
- ★ **What part of Earnings goes into Operating Expenses.**
- ★ **What part of Earnings goes into Wages . . . Taxes.**
- ★ **How much New Capital was Invested . . . How much for Refunding.**
- ★ **How much Money the Utility Industry will spend for New Construction in 1940.**

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(If you are already a subscriber to Electrical World, you will automatically receive the January 13, 1940 Statistical Issue without extra cost. But if you want extra copies, we suggest you make your reservation now. Use the handy coupon!)

★ Please reserve.....copies at $1.00 each, postpaid, of the 36th Annual Statistical Number of Electrical World . . . including the Chart Supplement showing OUTPUT CURVE from 1902-1940. Please send my copies and bill to me at the address indicated in this coupon.

★ Please enter my subscription to Electrical World for one year, with the understanding that the January 13 Statistical Number (and OUTPUT CURVE from 1902-1940) will be included without extra cost to me. Please bill me for 52 issues at $5.00—(annual subscription price U.S.A.)

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NEWS ABOUT PEOPLE

▶ C. E. DAVIES, secretary of the American Society of Mechanical Engineers, was elected secretary of the Engineers' Council for Professional Development at the recent annual meeting.

▶ J. WHITE of Stuart, Iowa, has been appointed as superintendent for the new municipal light and power plant at Bancroft, Iowa, which is to be ready for operation soon.

▶ C. V. DUNN, until recently superintendent of the service department of the Kansas City Power & Light Co., has been designated to head a newly created company department for the "technical advice and promotion of new and adequate wiring methods." Mr. Dunn will work in an advisory capacity with all departments under a company program for the betterment of house-wiring practices.

▶ J. R. ALLIN, manager of the Virginia Electric & Power Co.'s branch station at Stony Creek, has been made superintendent of the Prince George-Surry rural electrification project undertaken by the Rural Electrification Administration.

▶ DOUGLAS DOW, who has been connected with the Detroit Edison Co. for a number of years, most recently in the stores department, has been named chief of research for that company, to succeed the late Dr. Clarence F. Hirshfeld. Mr. Dow spent four years with the General Electric Co. following graduation from the University of Michigan in 1922 and then joined the Detroit Edison staff. He served as commissioner of purchases and supplies as a member of the Mayor's Committee on Efficiency and Economy in Detroit, 1931-32. In the latter year he became associated with the controller's staff of Detroit Edison Co. and subsequently entered the stores department. In 1935 He served on the staff of ELECTRICAL WORLD to aid with the development and publication of the National Recovery Number of March 30.

National Safety Council Elects Stilwell Head

Col. John Stilwell, vice-president of the Consolidated Edison Co., was elected president of the National Safety Council at its national congress which met recently in Atlantic City. The election of Mr. Stilwell marked the first time in the history of the council that an officer of a public utility company was elected to the presidency. He has been a director of the council since 1937.

For many years Colonel Stilwell has been active in safety work. In 1936 he was elected vice-president in charge of operations of the Greater New York Safety Council and in 1937 was appointed president of that council, following the death of Arthur Williams. This year he resigned from the presidency.

Colonel Stilwell has completed more than thirty years of service with the Consolidated system.

•

▶ JOHN F. MCBRIDE, who has supervised advertising and promotion on General Electric ranges from headquarters during the past two years, has been named field representative on ranges and water heaters for the company with headquarters in Minneapolis.

▶ H. F. HARVEY, JR., electrical engineer Newport News Shipbuilding & Drydock Co., Newport News, Va., has been appointed chairman of the A.I.E.E. committee on applications to marine work for the year 1939-40.

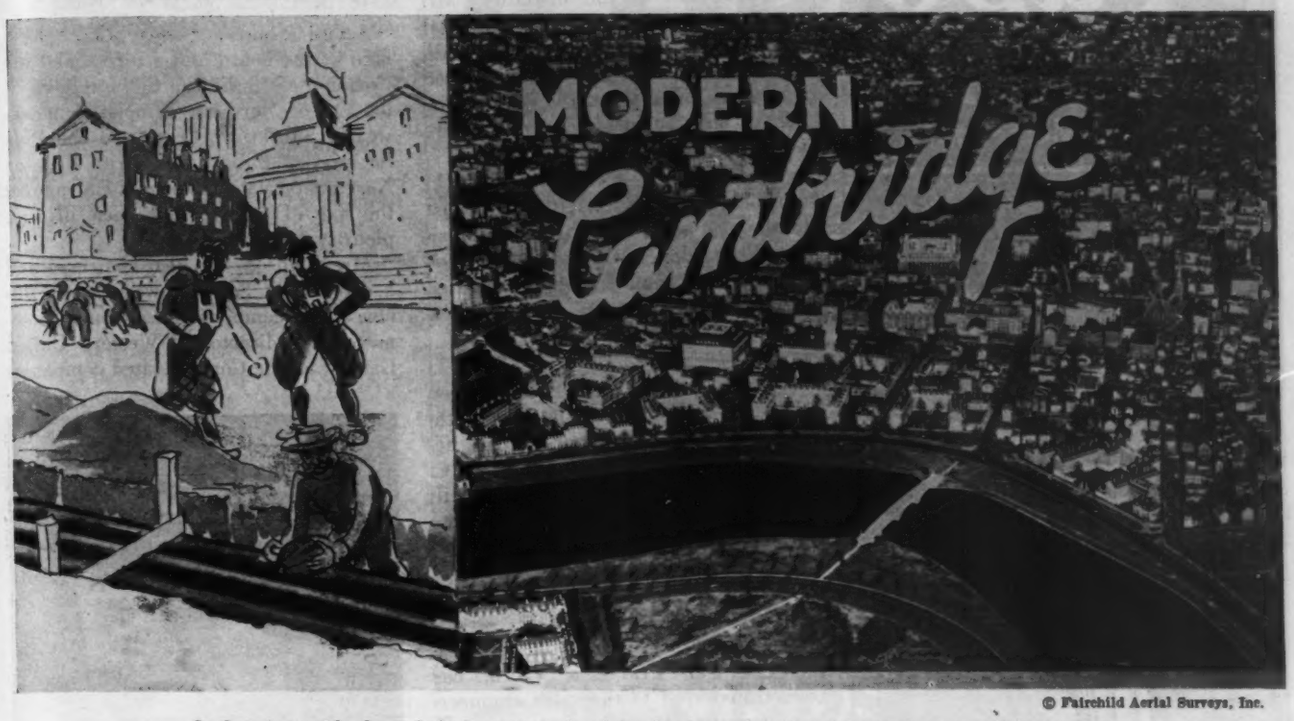
▶ D. S. SMITH, formerly power apparatus engineer, Northern Electric Co., Ltd., Montreal, Que., has joined the staff of the National Research Council, department of physics and electrical engineering at Ottawa, Canada.

▶ H. R. HAGGARD has been named manager of the new municipal electric power system at Gallup, N. M., recently established when the city acquired the properties of the New Mexico Public Utilities Co. Mr. Haggard was head of the utility company's properties in Gallup for the past ten years.

▶ JAMES L. ASHLEY, secretary and treasurer of the International Nickel Co. of Canada, Ltd., who has been an executive since the formation of the original International Nickel Co. in 1902, has elected to retire from these positions under the company's retirement system. While Mr. Ashley now retires as an officer of the company, he will continue to serve in an advisory capacity for several months. He remains as a director of the International Nickel Co. of Canada, Ltd., and its various subsidiaries.

▶ LEWIS H. BROWN, president of the Johns-Manville Corp., received the Vermilye Medal from the Franklin Institute on November 14 in recognition of "outstanding contribution in the field of industrial management." In accepting the award, Mr. Brown declared that the "first and greatest task" of those who would solve the nation's problems

ORANGEBURG HAS *long* BEEN PART OF



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In keeping with the scholarly approach of its famous educational institutions to all important problems, Cambridge was careful to select for its efficient underground distributing system only conduit that passed the most exacting laboratory tests.

If you'll add up all the ORANGEBURG points that count, compare it with any other conduit, weigh its advantages fairly and squarely, we are satisfied to abide by your own decision as to which conduit will give you the best — longest — and most economical 100% cable protection.

Consider the "ORANGEBURG Points that Count"

The Orangeburg trademark is a guarantee of the best of Fibre Conduits, a time-tested, enduring "service" of cable protection wherever electrical raceway facilities are to be installed underground.

● In every minute technical detail of engineering and manufacturing, you'll find ORANGEBURG Conduits far ahead. Since 1893, ORANGEBURG'S constant research has developed many product improvements that have kept it to the forefront, in terms of immediate and ultimate economy, and, most important, decades of trouble-free cable protection.

ORANGEBURG offers strength in excess of any other conduit and absolute immunity to soil corrosion and cable sheath deterioration.

Precision engineering eliminates installation difficulties. Light weight simplifies transportation and handling.

For installation underground with CONCRETE ENCASEMENT: ORANGEBURG STANDARD fibre conduit is recommended for duct banks (4 ducts and over), main distribution, high tension and "downtown" locations.

For installation WITHOUT CONCRETE ENCASEMENT: the ORANGEBURG dual-economy NOCRETE conduit is recommended for service entrances, extensions, parkways, and street lighting, suburban distribution, laterals, signal systems, etc.

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NOCRETE for installation *without* concrete encasement

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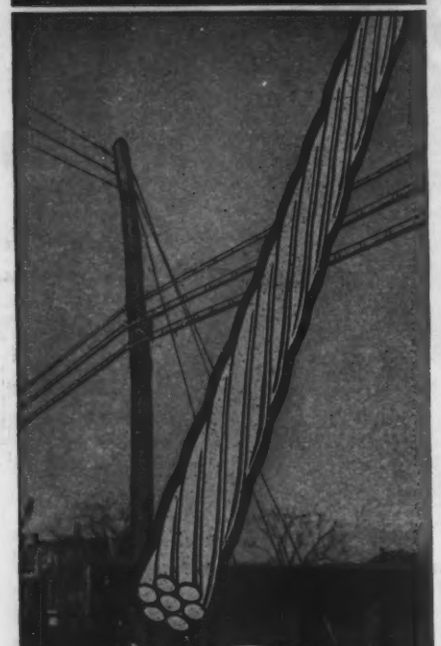


ALL the STRENGTH and DURABILITY NEEDS DEMAND

The superior tensile strength that only steel can give . . . . the ruggedness to withstand severe punishment . . . . the ability to outlast normal needs . . . All these are combined—with outstanding economy—in Crapo Galvanized Guy and Messenger Strand.

Long life and low maintenance costs are characteristic of this time-tested product. Heavy, ductile, tightly-adherent zinc coatings, applied by the Crapo Process, provide lasting protection against corrosion. The inherent strength and endurance of the steel makes for dependable, maintenance-free service.

Crapo Galvanized Steel Strand is readily available in all standard grades and sizes from representative jobbers.

Crapo Galvanized Products also include Crapo HTC-130 and HTC-80 Steel Conductors (Solid and Stranded 3-Wire), Construction Wire, Tie Wire and Ground Wire.

INDIANA STEEL & WIRE CO.
MUNCIE INDIANA

is "to set out courageously to rebuild confidence in America." Mr. Brown received the medal from Philip C. Staples, president of the institute. Mr. Vermilye, vice-president of the National City Bank of New York, who established the medal, said: "I determined to add my mite to making those who control our business destinies more management-conscious."

▶ FREDERICK J. GRIFFITHS, who last month was made executive vice-president of the Copperweld Steel Co., Glassport, Pa., to head the newly created steel division, has been elected to the board of directors.

▶ MAYNARD D. CHURCH has been elected a vice-president of the Worthington Pump & Machinery Corp., according to an announcement by H. C. Weaver, president. Mr. Church will continue as president of the Moore Steam Turbine Corp., a subsidiary of Worthington Pump.

▶ L. V. BANTA, formerly sales service engineer, Edison Storage Battery Supply Co., San Francisco, Calif., has been transferred to the sales engineering department, storage battery division, Thomas A. Edison, Inc., West Orange, N. J. Some few years ago Mr. Banta was identified with the staff of ELECTRICAL WORLD.

▶ CARL A. BOCK, chief consulting engineer of the Tennessee Valley Authority, has resigned to return to private practice in Dayton, Ohio. Mr. Bock was the first engineer to be employed by the TVA with its creation in 1933. Mr. Bock expressed the belief "that the TVA could make more intensive use of available consultation to insure economy and efficiency in the great projects which it is designing and building." In his letter of resignation to Chairman H. A. Morgan of the authority, he said "valuable opportunities for improved operating features can be overlooked or large sums needlessly spent unless such projects are subjected to independent searching analysis."

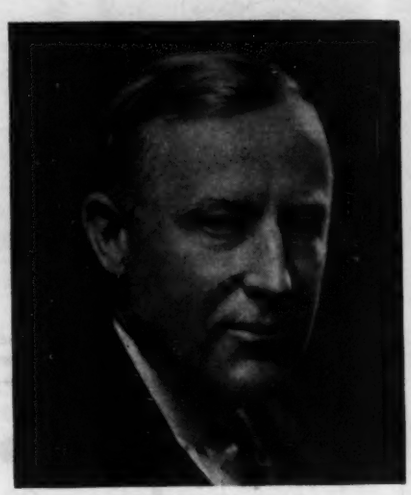
▶ JAMES WILSON, who recently was elected president of the Shawinigan Water & Power Co., has also been named president of the St. Maurice Power Corp., which is jointly owned by Shawinigan and the Brown Corp. J. B. CHALLIES was elected a director to fill the vacancy caused by the death of Julian C. Smith and he was also named secretary and vice-president. Directors of the St. Maurice Power Corp., also elected the following other officers: O. B. Brown and Wentworth Brown, vice-presidents; and W. S. Hart, treasurer.

OBITUARY

James Simpson

James Simpson, since 1932 chairman of the board and a director of the Commonwealth Edison Co., Public Service Co. of Northern Illinois, Commonwealth Subsidiary Corp. and the Public Service Subsidiary Corp., died on November 25 at his home in Chicago, at the age of 65. He had been ill with pleurisy for several weeks.

Mr. Simpson was also chairman and a director of Super-Power Co. of Illinois and a member of the executive committee and director of Western United Gas & Electric Corp., related companies



in the former Insull organization, which Mr. Simpson directed as chairman of Commonwealth Edison and Public Service.

Born in Glasgow, Scotland, Mr. Simpson was brought to this country by his parents in 1880. After attending a business college in Chicago he entered the employ of Marshall Field & Co. as a clerk in the cashier's office in 1891. He was serving as chairman of the board when he resigned in 1932 to undertake the salvaging and reconstruction of the broken utilities system of Samuel Insull.

The success with which he handled the difficult task assigned to him resulted this year in the completion of a huge refunding operation, in the course of which fifteen life insurance companies bought $114,500,000 of 3¼ per cent bonds.

•

▶ LOUIS B. MARKS, a consulting engineer specializing in the illumination field, died November 22 at his home in New York after a long illness. He was born in New York City 70 years ago. He was lighting expert with the Washington Carbon Co., Washington, Pa., 1890-93, and in 1893 invented and was granted basic patents on an "enclosed

arc" lamp, for which he was awarded a gold meal by the Paris Exposition of 1900. Mr. Marks designed the lighting plans for many municipal, State and Federal buildings. He was the first president of the Illuminating Engineering Society, having been elected to that office in 1906.

▶ FRANK A. ALEXANDER, president of the Southern Pennsylvania Power Co., Philadelphia, and general manager of the Conowingo Power Co., died November 21 at the age of 48 after a year's illness. Mr. Alexander was president of the Maryland Utilities Association.

▶ BERTRAM S. MCKENZIE, consultant to the Canadian Engineering Standards Association, died on October 6. In 1925 Mr. McKenzie was appointed secretary of the Canadian Engineering Standards Association, and continued in that capacity until June, 1937, when due to ill health he found it necessary to partially relinquish active work and was appointed consultant to the Canadian Engineering Standards Association secretarial staff. He was 63 years of age.

▶ ROBERT L. ST. JOHN, 55, well known in California through 30 years connection with the electrical industry, died in San Francisco, November 4. Perhaps his most outstanding job was the lighting and electrical system for the San Francisco Opera House. Mr. St. John's first associations with the industry in California were as a wireman and later a contractor in San Diego. For the past fourteen years he carried on a consulting engineering practice, engineering the electrical features of such projects as theaters, schools and hospitals. At the time of his death he was working on plans for the Protrero low-rental housing project.

▶ CHARLES W. G. LITTLE, retired chief engineer, British Electrical Federation, London, England, died recently. Born in England and educated at Finsbury Technical College, Mr. Little became associated in 1866 with the Thomson-Houston International Electric Co., Boston, Mass., was transferred in 1891 to the French Thomson-Houston Co., Paris, and then joined the newly formed British Thomson-Houston Co., Ltd. In 1899 he joined the British Electric Traction Co. as chief executive electrical engineer, being connected with lighting, power and traction undertakings in England and also in New Zealand and India. Later he became identified with the British Electrical Federation, and in that connection was sent to Brazil, Argentina and Russia. Mr. Little was a member of the Institution of Electrical Engineers of Great Britain.

. . . a tip on how to maintain continuous service

A terminal board flashes over . . . or a sheared bolt wedges itself between rotor and stator . . . then you've got *fire* on your hands! And the man who wants current doesn't care whether a transformer or a generator caused the trouble.

Fire will break out. You can't stop that. Fire knocks the spots out of output, makes continuous-service records look bad. *You can stop that!*

Halt Fire Damage at Point-of-Rupture

Choke fire instantly with a blizzard of LUX carbon dioxide. Station Lux Built-In Systems where they do most good — at generators, rotary converters, transformers, etc. Keep Lux portables near smaller machinery. There's your answer!

Fast fire-killing action of Lux cuts losses deeply, reduces "outages". Free brochure, "Lux Makes The Difference", will bring some interesting facts about fire control, plus a list of Lux installations in well-known utility plants. Describes Built-In and Portable equipment. Write for your copy.

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LETTERS TO THE EDITOR

Utility Responsibility for Wiring

To the Editor of ELECTRICAL WORLD:

I was very much interested in the article appearing in the current issue of ELECTRICAL WORLD (November 4) entitled "The Real Power Bottleneck."

The last half of the last paragraph appeals particularly. I hope that the WORLD will keep pounding away at this thought, as, particularly in the residence field, there is at the present time no particular interest or demand on the part of the average customer for anything more in the way of provision for service than he now enjoys, and that is meager, indeed.

If the utilities would see to it that the premises of at least 10 per cent of their customers were provided with a super-adequate amount of wiring and fixtures, regardless of the concessions that might be necessary, it would not be long before "keeping up with the Joneses" would result in a great awakening as to the possibilities in the sale of electric service and conveniences, and a very great increase in the adequacy of wiring everywhere.

J. F. GILCHRIST, Vice-President
Commonwealth Edison Company,
Chicago, Ill.

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Distance by Speedometer

To the Editor of ELECTRICAL WORLD:

I read with interest the article appearing on page 66 of the August 26 issue, "Distance Meter Estimates Lines," and the contribution to this subject by John B. Stuard, district engineer, New England Tel. & Tel. Co., Bangor, Maine, in a letter to you appearing in the October 7, 1939, issue of ELECTRICAL WORLD.

I have used Mr. Stuard's idea, but in a more accurate form. I removed the number ring from my speedometer which indicates tenths of miles and actually divided each tenth into ten equal divisions. Then I supplied a vernier scale to attach to the speedometer face plate and assembled the whole so as to have the vernier just visible in the edge of the window where the one-hundredth mile markings appear on the tenth mile number ring. Thus you can read accurately to 5.28 feet.

A further refinement can be added in the form of a magnifying glass focused so as to enlarge the vernier scale and moving scale and estimate fractions of divisions bringing the accuracy to about 2 feet.

This device is not difficult to make and with reasonable care in dividing, the scales can be made quite accurate. I have checked the instrument I built on various measured courses and found it to be surprisingly accurate.

Care must be exercised in its use to obtain accuracy; that is, start and stop easily to avoid wheel slip, never reverse the car between readings, drive slowly and allow the car to roll of its own momentum as much as possible over the course to be measured, and keep tires fully inflated.

W. J. BRIDEGAM,
Test Engineer
Utility Management Corp.,
Reading, Pa.

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Fuel Clauses

To the Editor of ELECTRICAL WORLD:

In your issue of October 7, 1939, there appears an article entitled "Fuel Clauses—Are They Always Adequate?" by F. W. Foster. Mr. Foster works out the appropriate adjustment charge per kilowatt-hour for one cent change in the cost per million B.t.u. of fuel by considering the unit fuel cost per kilowatt-hour under present conditions and under the condition of a one cent increase per million B.t.u. in the total cost of fuel and, of course, arrives at the correct answer.

However, he did not mention the fact that the same answer can be obtained more simply by calculations based solely on the incremental cost of fuel. That is, if the station economy is 17,353 B.t.u. per kilowatt-hour (and, by the way, this should be on the basis of kilowatt-hours *sold* rather than kilowatt-hours *produced*), each million B.t.u. in fuel will produce 57.627 kilowatt-hour. Therefore, if fuel changes one cent per million B.t.u. the unit change is one cent divided by 57.627, which is 0.017353 cent.

$$\frac{1{,}000{,}000 \text{ B.t.u.}}{17{,}353 \text{ B.t.u.}} = 57.627 \text{ kw.-hr.}$$

$$\frac{1.000{,}000\ ¢}{57.627 \text{ Kw.-Hr.}} = 0.017353\ ¢$$

$$\frac{17{,}353 \text{ B.t.u.}}{1{,}000{,}000 \text{ B.t.u.}} = 0.017353\ ¢$$

An inspection of the formula shows that we are dealing with reciprocals and that if the station economy in B.t.u. per kilowatt-hour is divided by one million B.t.u. we obtain the increment adjustment in cents per kilowatt-hour. Thus, we have a simpler method of determining the correct increment adjustment figure.

ROYAL M. BARTON,
Rate Department,
Ebasco Services, Inc.
New York, N. Y.

ELECTRICAL MEN WANT NEWS OF THEIR BUSINESS

•

Another Important Reason Why GOOD ADVERTISING PAYS IN ELECTRICAL WORLD

"We Know the Results Are There..."

Mail order selling doesn't perform much of a role in the electrical industry. Few companies expect that it can or will. Advertising is used, logically, to make the job easier for salesmen. Successful companies use Electrical World . . . successfully for that all-important purpose.

Here are two more examples of Electrical World advertisers who are doing it

THE ELECTRIC STORAGE BATTERY COMPANY of Philadelphia has long enjoyed a position of eminence in the electrical industry. Advertising has done its share in building its business. Promotion of Exide batteries in ELECTRICAL WORLD was started before the turn of the century — and is still going strong.

A. N. Dingee, advertising manager, puts it this way: "We have never questioned advertising. We have questioned media. ELECTRICAL WORLD has been on our schedules for forty years. There can be only one reason. We feel that it helps us sell our product within the field of its influence."

SIMPLEX WIRE & CABLE COMPANY of Cambridge, Mass., is another one of our pioneer companies that has won — and maintained — an enviable degree of success. Here, too, persistent and dominant advertising in ELECTRICAL WORLD — half a century of it — has been a strong contributing force.

Arthur F. Lewis, advertising manager, makes this comment: "Simplex advertising has been a part of ELECTRICAL WORLD for about 50 years. During that time the amount of space used annually has varied considerably with changes in business conditions, but 50 years of continuous advertising would seem to indicate our opinion of the value of ELECTRICAL WORLD as an advertising medium.

"Our advertising in ELECTRICAL WORLD has been designed primarily to prepare the way for our sales people. When properly supported by the other work of our advertising department it has done what it was designed to do and has made our selling easier and more resultful. It is difficult to evaluate the results of our advertising, *but we know the results are there.*"

ELECTRICAL WORLD

Serving a Huge and Ever-Growing Market

A McGraw-Hill Publication, 330 W. 42nd St., N.Y.C.

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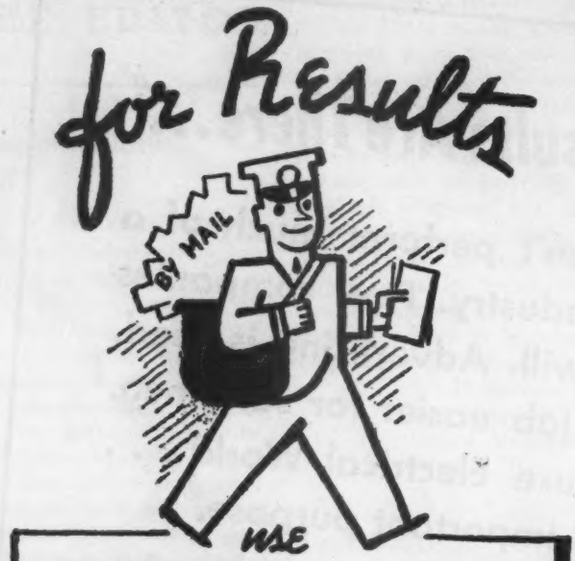

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Municipal Plants

KENNETT, MO.—Ending a drawn-out legal battle with the Arkansas-Missouri Power Co., the city has won the right to proceed with construction of a $140,000 municipal electric plant. In a ruling filed in Federal Court at Cape Girardeau, District Judge George H. Moore dissolved a temporary injunction and dismissed the power company's suit against the city and companies with which it had contracted for the plant and equipment. The power company, which has a distribution plant at Kennett, started litigation after the city voted bonds for a municipal plant in 1933. Judge Moore granted the company a temporary restraining order in 1938.

NEWTON FALLS, OHIO—Work on the construction of a new municipal light plant is now going forward as a result of a recent decision of the Ohio Supreme Court which, with the consent of all parties, allowed a writ to prohibit Common Pleas Court Judge Dewey B. McVickery and other common pleas judges of Trumbull County from considering a case brought by the Ohio Public Service Co. to prevent the village from proceeding with construction of the municipal plant. The Supreme Court previously had held that the city had a right to build the plant, but the Ohio Public Service Co. entered another suit to delay the construction work. The village then sought the order to prevent the court from considering the new case, on the ground that the matter had been adjudicated in nine previous suits, all won by the village, and that the action was "frivolous and vexatious."

YORKTOWN, TEX.—Attorney General Gerald C. Mann has filed suit in Ninety-Eighth District Court, charging the Central Power & Light Co. with violation of the anti-trust laws and seeking penalties, lien and injunction against carrying out an agreement allegedly in restraint of trade. In a municipal election in 1936 citizens voted to issue bonds to set up a light and power plant and distributing system by a vote of 204 to 171. After the election carried, the petition alleges, the Central Power & Light Co. paid to the city $10,000 and made other valuable concessions to have the city forego the building of the plant, with the intent and purpose of defendant to set aside the will of the people as expressed in the election and further to prevent and lessen competition, restrain trade and block the free channel of business. The city withdrew its application for a federal grant, according to the petition and repealed certain resolutions in connection with the proposed municipal plant. By reasons of the facts set out in the petition, the Attorney General declared the Central Power & Light Co. has become liable to the State of Texas for the penalties under the anti-trust laws of the state in the sum of from $50 to $1,500 per day from October 18, 1937, to the time of entry of judgment in this case.

ADAMS, WIS.—Wisconsin Public Service Commission by a vote of 2 to 1 has refused to give the city additional time to purchase the property of the Wisconsin Power & Light Co. for $36,000. The sum was approved by the commission.

GALLUP, N. M.—The town of Gallup recently exercised its option to purchase the property of the New Mexico Public Utilities Co. at a price of $500,000. Final details of the purchase were concluded in a conference of members of city coun-

cil and representatives of the bonding company, through which the deal was arranged, in which the necessary transfers were made, payment authorized for the revenue bonds sold and corresponding payment to the utilities company.

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Recent Rate Changes

WISCONSIN GAS & ELECTRIC Co's new rate schedule effecting a $50,875 annual reduction in commercial electric rates for 7,800 customers, effective with the first meter reading after November 1, has been approved by the state Public Service Commission.

COLUMBUS & SOUTHERN OHIO ELECTRIC Co's new residential light rates for 79,764 Columbus, Ohio, consumers became effective recently as a result of voters approving the new rates at the election held this month. An average reduction of 8 to 15 per cent is included in the new residential rate structure, and will total about $300,000 annually, or $1,500,000 over the five-year period of the ordinance. The former rate was: 30 kw.-hr. at 5 cents each; next 60 kw.-hr. at 4½ cents each; next 60 kw.-hr. at 4 cents each and excess at 3 cents each. The new rate is: 40 kw.-hr. at 4½ cents each; next 60 kw.-hr. at 4 cents each; next 60 kw.-hr. at 3 cents, and all over 160 kw.-hr. at 2½ cents each.

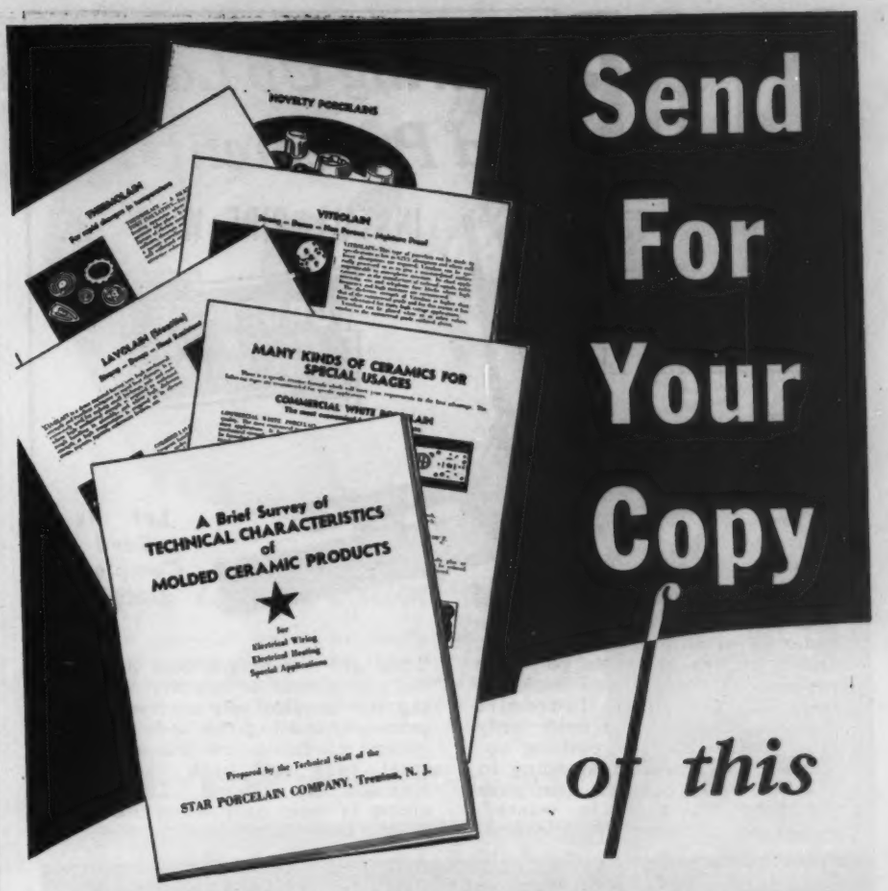
NIAGARA, LOCKPORT & ONTARIO POWER Co. and the Lockport and Newfane Power & Water Supply Co. have filed revisions of electric rates with the New York Public Service Commission which are estimated to save consumers of the companies more than $116,300 annually. The commission permitted the reduced rates to become effective November 30. The general reduction in residential electric rates filed by the companies includes a standardization of the minimum charges for seasonal electric service. Reductions are also made in the rural minimum charge of the commercial rates. The decreases made in the residential rates in the various districts of the Niagara, Lockport & Ontario Power Co. will save consumers about $109,800 annually. Reductions in the commercial rural minimum charge will save customers of that company an additional $4,500 a year. The reductions filed by the Lockport and Newfane company will save consumers of that company about $2,000 annually.

•

Electricity Foreseen as Death to Pests

Elimination of harmful insects by various forms of radiant energy suggests almost unlimited possibilities, according to Dr. Guy F. MacLeod of the entomology division of the University of California College of Agriculture. He points out that while X-rays, infra-red rays, ultra-violet light, etc., are known to kill insects, studies of their application to specific problems in pest control are only just getting under way.

He also pointed to the apparent success with which high frequency has been employed in Eastern grain mills to kill organisms by heating their internal organs.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Prepared by the Technical Staff of the STAR PORCELAIN COMPANY, Trenton, N. J.

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to Help You Select the Right Porcelain for Your Job

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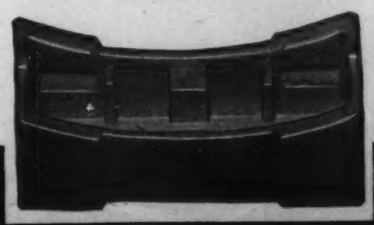

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This tool is compact, easy to handle and simple to operate. Pumping the handles sets up hydraulic pressure, causing the body of the pusher to travel on the notched steel base and push the pipe through the ground. The pipe clamp is reset only when the end of the base is reached.

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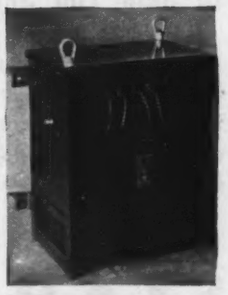

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Sales Opportunities

RED WING, MINN.—Northern States Power Co., Eau Claire, Wis., has plans under way for new transmission line from Menomonie, Wis., to Red Wing, close to 40 miles. Work is scheduled to begin soon.

GREENFIELD, IOWA—Town Council receives bids until December 12 for extensions and improvements in municipal power plant, including addition to present building and installation of certain equipment. Stanley Engineering Company, Muscatine, Iowa, is consulting engineer.

WILLIAMSPORT, PA.—Lycoming Division of Aviation Manufacturing Corp., manufacturer of airplane engines and parts, plans installation of motors and controls, conveyors, electric hoists and other equipment in connection with modernization and expansion in plant. Cost estimated about $400,000. Work will be placed under way at early date. Main offices of parent company are at 420 Lexington Avenue, New York, N. Y.

FENNIMORE, WIS.—City Council has authorized plans for new municipal electric power station, estimated to cost about $70,000, in which amount an appropriation is being arranged. George H. Leiser, Portage, Wis., is consulting engineer.

PORTLAND, ORE.—Administrator, Bonneville Project, 811 N. E. Oregon Street, Portland, receives bids until December 18 for transmission line over Ship Canal crossing on route between Bonneville station and The Dalles, Ore., of Bonneville transmission system, including steel towers, conductors, ground wire, airway marking and lighting towers, etc. (Circular 633).

PANGUITCH, UTAH—Garkane Power Co., Panguitch, plans extensions in generating station, including installation of additional equipment. Financing has been arranged through Federal aid.

MOUNT GILEAD, OHIO—Hydraulic Press Manufacturing Co. plans installation of motors and controls, switchgear, conveyors, electric hoists and other equipment for expansion and improvements in heavy machinery-manufacturing works. Cost about $500,000. Appropriation in that amount is being arranged through sale of stock.

STILLWATER, OKLA.—Board of City Commissioners plans expansion and improvements in municipal power station and waterworks plant, with installation of a new 4000-kw. turbine-generator unit, boiler and auxiliary equipment. Cost estimated over $285,000. Also plans extensions and modernization of electrical distribution system, including power substation units. Cost estimated close to $335,000.

PHILADELPHIA, PA.—Pennsylvania Salt Manufacturing Co., Widener Building, plans installation of motors and controls, power substation apparatus, regulators, conveyors and other equipment in new chemical-manufacturing plant on site now being selected near city, to replace present factory on 62-acre tract of land on waterfront at Delaware and Oregon Avenues, sold recently to Philadelphia Electric Co. as site for new steam-electric generating station. New plant will consist of group of one and multi-story units,

and is reported to cost in excess of $2,500,000.

LAKELAND, FLA.—City Commission has authorized an additional fund of $64,000 to make a total appropriation of $435,000, for expansion and improvements in municipal electric power station, including installation of additional equipment. Part of financing has been arranged through Federal aid.

BIRMINGHAM, ALA.—Alabama Power Co. is arranging an appropriation of about $1,000,000 for expansion in primary and secondary lines for rural electrification in different districts during 1940, including power stations and service facilities.

FORT HUACHUCA, ARIZ.—Quartermaster, Fort Huachuca, is planning an immediate call for bids for furnishing and installing new convertible gas-diesel engine-generating unit and auxiliary equipment in local power plant.

MADISON, WIS.—Wisconsin Power & Light Co., Madison, plans extensions in transmission lines in parts of Dane, Walworth and Langlade Counties. Work is scheduled to begin soon.

NEW PROVIDENCE, N. J.—Bell Telephone Laboratories, Inc., 463 West Street, New York, N. Y., plans installation of motors and controls, regulators, switchgear and considerable special and standard electrical apparatus in new laboratory at Murray Hill, near New Providence (New Providence Township), where large tract of land was acquired several months ago. Project will consist of a group of main T-shaped structures, with number of auxiliary operating buildings, and is estimated to cost about $3,000,000. Award for building erection has just been made to John Lowry, Inc., 630 Fifth Avenue, New York. Completion is scheduled early in 1941.

NEW YORK, N. Y.—New York Giants Club, 104 West Forty-Second Street, plans installation of new night-lighting system at Polo Grounds, Eighth Avenue and 155th. Street, with steel towers, feeder circuits, control switch house, field lighting units, etc. Cost estimated over $125,000.

STROMSBURG, NEB.—Polk County Public Power District, Stromsburg, plans primary and secondary lines for extensions in rural electric system in part of Polk County, including power substation and service facilities. Cost about $50,000. Financing has been arranged through Federal aid. Work will be placed under way soon.

OIL CITY, PA.—Quaker State Oil Refining Co., Oil City, plans installation of motors and controls, conveyors, electric pumping machinery and other equipment for expansion and improvements in oil refining plants at Emlenton and Farmers Valley, Pa., and at St. Mary's, W. Va. Cost estimated over $300,000. Proposed to begin work at early date.

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Seattle Issues Bulletin

Publication of a monthly official bulletin, *Powerfax*, containing items of timely interest to customers of Seattle City Light, has been announced by Eugene R. Hoffman, snuperintendent. The bulletin will be mailed with monthly light bills.

Says the Wizard of O-Z

● Avoid accidental grounds by installing O Z Insulated Bushings at every cable entrance. These husky bushings are made of tough malleable iron (cadmium plated or hot-dipped galvanized) as well as Bronze, Aluminum and in special alloys. All sizes from ½ inch to 6 inch conduit . . . completely listed in O Z Catalog No. 4. Have you a copy?

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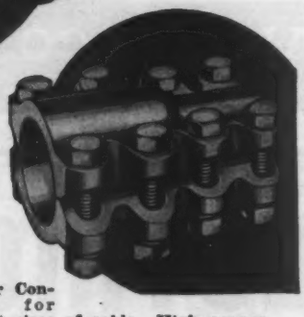

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Conductor Fittings

Power-Factor Testing of Transformer Insulation

[*Continued from page 50*]

and C_L were very high in comparison with C_{HL}:

Two-Winding Transformer

23/2.4 50 kva.

	Current Amperes	Watts	Test Voltage Kv.	Power Factor	Power Factor at 20 Deg. C.
C_H	0.543	0.754	10	15.4	11.1
C_L	2.633	3.146	10	13.3	9.75
C_{HL}	2.308	0.844	10	4.0	2.97

As the bushings connected to these windings were tested and found to be normal, it was assumed that the oil in the transformer was probably the cause of the high power factors. The power factor tests on the oil gave 11.5 per cent at 20 deg. C. It was only necessary to filter the oil to regain normal insulating values on this transformer.

2. The following test data were obtained on a transformer in the field:

Two-Winding Transformer

22/2.3 333 kva.

	Current Amperes	Watts	Test Voltage Kv.	Power Factor	Power Factor at 20 Deg. C.
C_H	2.267	0.547	5	4.8	3.98
C_L	2.912	3.407	5	23.4	19.4
C_{HL}	1.394	0.402	5	5.8	4.8

It will be noted that C_L is very much higher than C_H and C_{HL}. The first analysis would indicate that either the bushings associated with the low-voltage winding were faulty or that the low-winding terminal board, insulation in the winding, etc., was defective. Test on the bushings proved that they were in satisfactory condition and the fault was found to be due to carbonization on the terminal board. It is also noted that C_H and C_{HL} are slightly higher than normal. This was found to be due to sludge and acid in the oil. Replacing the terminal board and filtering the oil in the transformer brought the power factors down to less than 2 per cent.

3. The following over-all power transformer tests indicate that there was a possibility of a defective bushing associated with the high-voltage winding:

Two-Winding Transformer

66/22 200 kva.

	Current Milli-amperes	Watts	Test Voltage Kv.	Power Factor	Power Factor at 20 Deg. C.
C_H	2.387	1.905	10	8.0	5.0
C_L	5.672	1.585	10	2.8	1.8
C_{HL}	3.518	1.025	10	2.9	1.8

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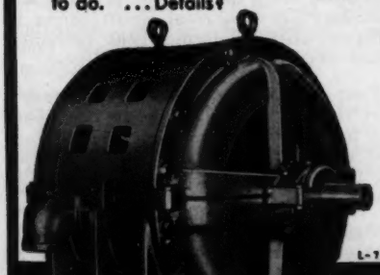

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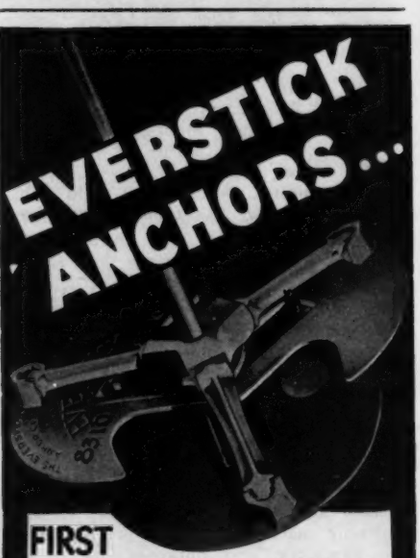

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In Dependability and Safety!

Made of Malleable Iron—proven on the toughest guying jobs—you can't go wrong by using Eversticks exclusively.

THE EVERSTICK ANCHOR CO.

FAIRFIELD, IOWA

Bushing tests showed that one of the high-voltage bushings had a power factor of 18.2 per cent at 20 deg. C., while the other high-voltage bushing associated with the high-voltage winding had a power factor of 1.7 per cent and the low-voltage bushings each had power factors of approximately 2 per cent.

Consistent testing of power transformers by various utilities over the last few years has been well justified from an expense standpoint, inasmuch as many potential failures have been detected in their incipient stages. The reconditioning of these transformers has restored normal insulation conditions, and thus not only prolonged the life of the equipment but avoided possible failures and their accompanying direct and indirect expense.

Distribution Planning

[*Continued from page 48*]

ical use of existing facilities and, therefore, cannot usually be laid out in an ideal manner. The use of No. 3 secondary conductors and the use of 10-, 15- and 25-kva. transformers may necessitate primary extensions, which should follow an ideal plan as closely as local conditions will permit. Larger secondary conductor is not an economical substitute for primary extensions unless the larger secondary will provide facilities for the probable ultimate load conditions.

The principles of residential transformer-secondary design may be summarized as follows:

1. Transformer - secondary combinations should be redesigned when maximum voltage drop for the combination exceeds about 7 or 8 per cent, or when the maximum transformer load exceeds about 150 per cent.

2. New and redesigned transformer-secondary combinations should be designed for

(a) A maximum secondary voltage drop of about 2 or 3 per cent (not to exceed 3 per cent except in special cases).

(b) A transformer loading of between 90 and 140 per cent.

(c) A total maximum voltage drop for the transformer-secondary combination of 6 per cent or less.

3. No transformer-secondary combination should be designed or rede-

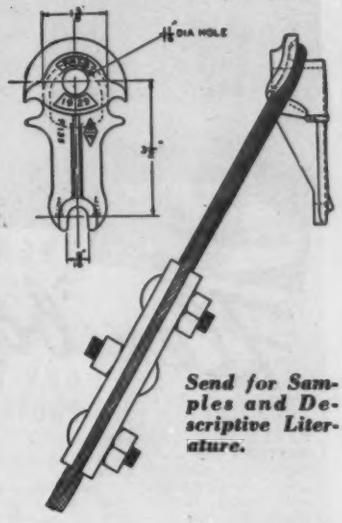
700,000 Installations Can't Be Wrong

The supplement with Electrical World issue of May 6, 1939, lists 145 Largest Generating and Distributing Systems in the U. S. 48 of these representative Companies and many other smaller properties regularly use M. I. F. Through-bolt Guy Hooks on exclusive or preferred specification basis. Investigation pays.

Guy Hooks— Three principal types in addition to the P134 Crossarm Guy Hook. P135 rated at 13,000 lbs. on ⅝" through-bolt is widely used for rural electrification. P133 rated at 20,000 lbs. on ¾" through-bolt. P132 rated at 40,000 lbs. on 1" through-bolt. Make up guy loops on the ground and save time of the whole gang. Prices as low as 15c each in quantity.

Eye Nuts and Anchor Rods— Thimbleless Eye Nuts for ⅝" bolt as low as 12c each in quantity. Larger sizes for ¾" and 1" bolts. Double Eye Nuts and various types of Bolt Eyes also available. Also furnished assembled and galvanized as unit on special steel rods of any desired length, rated at 80,000 lbs. per sq. in. at correspondingly attractive prices. These Eyes, used with standard stocks of through-bolts, round out simple specifications for pole-to-pole guys, etc., other than anchor type served by the Guy Hooks.

Curved Washers— Full line of Curved Ribbed Malleable Washers using the metal to better advantage than plate washers of uniform thickness, minimizing the pole-splitting stresses of through-bolt guying of any type, and strictly competitive as to price.



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HERE is a complete course of instruction for those who want to learn how to do electrical wiring. Begins with very first elements and takes the reader by easy steps, plain instructions and methods, to the completion of typical wiring jobs in accordance with official requirements. Employs simple language; confines mathematics and theory to the minimum necessary for understanding of the work; covers medium voltage jobs of the types that are most in demand.

Covers:

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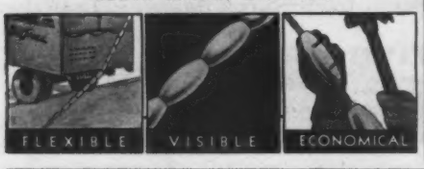

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signed without giving consideration to the adjacent combinations.

4. Secondary conductor sizes should be as follows, except in special cases:

(a) New secondaries should ordinarily be constructed of No. 3 conductors.

(b) No. 6 secondaries should usually not be replaced with larger conductors.

(c) No. 1/0 or larger conductor should not be used, except for apartment house areas, etc.

(d) Secondary neutrals should serve as a common neutral for primary and secondary on grounded neutral systems.

5. Secondaries should be banked, provided:

(a) The number of transformers whose secondaries are banked together does not exceed three or four transformers.

(b) There is a definite advantage to banking such as reducing excessive secondary voltage drops or reducing the number of transformer installations required.

(c) Twenty-five-ampere secondary fuse cutouts are installed at the point of minimum current flow.

6. Methods of eliminating objectionable flicker should be investigated in the following order of preference:

(a) Banking secondaries.

(b) Rearrangement of transformer to reduce the length of the secondary on which objectionable flickers occur.

(c) Use of auto-transformer at end of secondary.

7. In general, economical transformer sizes are 10, 15 and 25 kva.

8. Large secondary conductor is not an economical substitute for primary extensions unless the larger secondary will provide facilities for the probable ultimate load conditions.

The value and practicability of the above principles can best be appreciated after present voltage conditions have been calculated for a number of transformer-secondary combinations, and the same combinations have been redesigned in accordance with the above principles.

● "Checking Transformer-Secondary Conditions" is the subject of the next (sixth) article in a series of six on the technique of distribution design and analysis and will appear in "Electrical World," December 16. Reprints of the six articles collected in a stiff cover binding will be available when the series is completed. Edition will be limited and orders should be sent in early.

Trucks Geared to Specific Duty

[*Continued from page 46*]

placed or rebuilt. Taking advantage of this opportunity two types of trailers were designed which are expected to satisfy most of our operating conditions. One type (Fig. 8) is a pole trailer with stationary bunks and adjustable chocks having dual 6.50x20 tires on a standard 11,000-lb. Schuler axle. When hauling poles the center pole is used as a reach, with an especially designed drawbar for connecting it to the truck. A feature of the trailer is the stiff leg for supporting the forward end while loading. A hand lever attached to the vacuum brake system locks the trailer wheels whenever it is disconnected from the truck. The poles are fastened to the trailer by means of two binders, one at the front, which is applied only to the reach pole, and one at the rear, consisting of a cable and hand winch for binding the entire load together and also to the trailer. These trailers weigh 2,000 lb. with a pay load capacity of 8,000 lb. and a licensed capacity of 10,000 lb.

The other trailer (Fig. 9) is a platform type using a 6,000-lb. axle equipped with dual 6.00x16 tires. It can be used to haul one, two or three poles or material such as crossarms, wire, transformers, etc. For hauling poles two binders similar to the larger trailer are supplied. The top of the trailer is covered with a light gauge diamond plate welded to the frame. In most other respects it is similar to the larger trailer except that it has stake pockets along the side as well as hooks for fastening material loads. Its weight is 1,150 lb., with a pay load of 3,850 lb. and a licensed capacity of 5,000 lb.

Both types of trailers are equipped with vacuum-controlled brakes which are operated by means of a hand valve in the cab of the truck.

•

Buys Coal Properties

Puget Sound Power & Light Co., Seattle, has taken over the power and light distributing system in Black Diamond, near Seattle, owned by the Pacific Coast Coal Co., which for many years has purchased energy wholesale from the Puget Sound Co. and then retailed it to Black Diamond residents. Some rebuilding and line extension work is contemplated.

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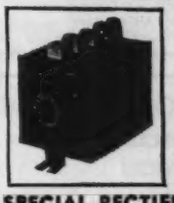

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Getting Along With People
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A Look at "Little TVA"

[*Continued from page 69*]

200 miles if a market is to be found, with consequent large line losses.

During 1937–1938 the district sold $50,305 of electricity and purchased $17,157 worth. It sold $4,041 of water for irrigation. Total income was $54,386. Salaries and wages were $4,761, supplies and miscellaneous $1,967, rate and market surveys $4,815 and direct operating expenses $28,702. This surprising report of the district to the Governor gives an idea of the economic status of this project with present assets of $11,807,328.

It is obvious that even if the project produces the estimated output it cannot sell it for 7.2 mills per kilowatt-hour to any available market for several years, if ever, and faces a deficit situation on its interest and amortization charges.

The Central Nebraska or Tri-County project is not yet completed. It has been allotted $30,096,000 by PWA, of which $13,543,000 is a gift and $16,553,000 a loan. When completed the power plants are expected to have an installed capacity of 60,000 kva. and an estimated annual output of 235,000,000 kw.-hr. Of the loan, 60 per cent, or $9,931,800, is charged to power. With interest, amortization and operating expenses estimated at $1,000,000 a year the unit cost of power is about 4.2 mills per kilowatt-hour. Here again the output that can be had from the available water is still unrealized and the market for the estimated power can be found only in the distant eastern part of the state, with consequent transmission losses and the necessity for local standby plants. The cost is quite high compared to the competitive market situation. In November, this year, the Iowa-Nebraska Power & Light Company, centered around Lincoln, contracted to purchase up to 6,250 kw. from Tri-County.

Possibly another way to look at "Little TVA" is to group the three projects together. The total PWA money allotted is $55,391,909, of which $20,713,909 is a gift and $34,678,000 is a grant. The total annual average estimated output is 513,000,000 kw.-hr., with a total power charge of $2,520,000 a year. This gives a cost of power of about 4.9 mills per kilowatt-hour.

It should be noted that this output is about 70 per cent of the entire power now used in the state of Nebraska, and even if produced cannot be sold into existing markets unless local utilities are prepared to abandon their present lines and stations. At the price, considering the service reliability and the problematical realization of the estimates, it is quite evident that "Little TVA" is not a gold mine for its promoters when measured in dollars and cents.

Power Markets

About 80 per cent of the electric power now used in Nebraska lies east of Columbus and is now generated by capacity located in this area. The western half of the state uses only about 5 per cent of the power. All the projects except the Loup lie in the western half of the state. Thus, even if all local towns are supplied from the power districts, the bulk of the power must be transmitted from 150 to 250 miles east to the large centers of population on a system that is unstable under most conditions of load.

Private utilities follow the policy of co-operating with the power districts through purchase and sale of power and interconnections. They lean over backward to smooth the way for the power districts. For example, Northwestern Public Service Company has sold its Columbus distribution system on a lease-purchase plan to the local Columbus power district, has interconnected its lines and stations with the districts and has offered to sell its western properties around North Platte. Nebraska Power Company has signed a contract for firm and surplus power on very favorable terms for the Loup district and Iowa-Nebraska Power & Light has signed a contract with the Tri-County District. But the power districts are still reluctant to "play ball" wholeheartedly for several reasons: (1) A desire to get a state-wide publicly owned power system; (2) no market as yet to sell even revenue bonds to get money; (3) a reluctance to get any more money from federal agencies because these agencies share management, and (4) the amount of firm and surplus power is still to be determined.

So far as the municipal plants are concerned the situation is also troubled. Many municipals have their own plants that make money and give

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good service. They are reluctant to take a chance on transmission service, hesitate to give control to the districts and are not attracted by the price at which district power is offered them. Several municipal plants, such as Grand Island, have taken a positive stand against district power, others which are served by interconnection find service poor and parallel operation difficult. The last Legislature gave evidence that the municipal plants in Nebraska are looking to retaining control of their local power supply and rates as well as the power of taxation.

Considering the "little TVA" as a whole and looking at the facts, it is evident that it is an uneconomic investment, with costs that cannot be met by the market price for either power or irrigation. To absorb the power either the price must be reduced or private and municipal utilities must subsidize the developments. The amount of firm power is negligible and thus the entire development can be placed in the seasonal or dump power class. There is little prospect of the government or other investors getting returns on the money spent.

The conclusion is inescapable that the "Little TVA" in Nebraska is uneconomic and has a hard financial, political and operating row to hoe before it is established as a going concern. It has brought money into Nebraska and built engineering structures that benefit the state, but it is doubtful if either power or irrigation will ever bring in sufficient revenues to pay for the cost incurred.

At the present time "Little TVA" has growing pains and is more a threat than an actuality as a power agency in Nebraska.

•

FPC to Probe Rates

Seeking to determine whether the rates and charges to be made by the Moline-Rock Island Manufacturing Co. to four companies distributing electric energy in Illinois and Iowa are just and reasonable, a hearing has been ordered by the Federal Power Commission for December 11 in the Federal Building at Davenport. Other issues at the hearing will be determination of whether the company is a public utility as defined in the Federal Power Act and whether it transmits electric energy in interstate commerce or sells electric energy at wholesale in interstate commerce.

Pick Up the Cudgels Again

[*Continued from page 74*]

ually come to distrust the public power crowd. Even when they talk about steam plants he feels no surge of enthusiasm.

But an inquiring reporter, canvassing such senators and representatives as happen to be in town, will find that no matter what the public power crowd is able to do to the utilities through SEC and TNEC, the legislative road to private utility punishment has got mighty muddy. George Norris is not the power he used to be in the Senate, and Rankin never was what his power bloc friends thought in the House. Whereas a rapidly increasing number, even of strong Roosevelt men in Congress, want peace and as much prosperity as possible until the election is over.

Texas Power Output Rises

Electric power consumption during September in Texas climbed 10.4 per cent over September, 1938, fourteen power companies have reported to the University of Texas Bureau of Business Research. Total consumption in September was 260,041,000 kw.-hr., compared with 257,557,000 kw.-hr. in August. For the first nine months of this year total consumption gained 7.3 per cent over the similar period last year.

•

City Plant Pays Back Taxes

The county treasury at Richmond, Ind., will be richer by $30,000 by reason of the payment of delinquent taxes on the municipal light plant there. Nullification by the last Legislature of an act requiring public owned utilities to pay state and county taxes did not excuse payment of delinquent taxes. Richmond was one of the Indiana municipalities which contested constitutionality of the act and let taxes go unpaid.

•

Drop Free Installations

Free installation of electric water heaters and ranges, provided by the Fort Wayne (Ind.) City Light and Water Utilities (municipal) and the Indiana Service Corp. during the past three years as a sales promotion aid, will be discontinued as of January 1, 1940, by both utilities. The announcement was made at a meeting of the two utilities with the electrical appliance dealers and distributors of the area.

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